Appendix A

Groundwater Conditions in the Firebaugh Canal Water District and CCID Camp 13 Drainage District

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GROUNDWATER CONDITIONS IN THE FIREBAUGH CANAL WATER DISTRICT AND CCID CAMP 13 DRAINAGE DISTRICT

prepared for
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Contractors Water Authority
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

GROUNDWATER CONDITIONS IN THE FIREBAUGH CANAL WATER DISTRICT AND CCID CAMP 13 DRAINAGE DISTRICT

INTRODUCTION

This report provides information on groundwater conditions in an area southwest of the San Joaquin River, near Firebaugh and Mendota. The project evaluated herein includes pumping of up to 20,000 acre-feet per year of moderate to high salinity groundwater into two Central California Irrigation District (CCID) Canals. This water would mix with canal water, most of which is derived from the Delta-Mendota Canal (DMC), and subsequently be used for irrigation. The study area selected for evaluation is generally bounded by the boundary of T11S and T12S on the north, the boundary of R12E and R13E on the west, the boundary of T13S and T14S on the south, and the San Joaquin River on the east (Figure 1). Two important parts of this area in terms of this evaluation are the Firebaugh Canal Water District (FCWD), and the Camp 13 Drainage District of the CCID (Figure 1). Groundwater in most of these two areas has generally not been pumped for direct irrigation use (without mixing), because of the high salinity (often exceeding about 3,000 mg/l of total dissolved solids (TDS). The wells proposed for pumping would be between the DMC and Main Canal and Fairfax Avenue and the City of Firebaugh. This report is organized as follows. First, existing groundwater conditions are described.

This is followed by an evaluation of potential impacts of the proposed project. The existing groundwater monitoring in the area is then discussed, followed by a proposed monitoring program.

EXISTING GROUNDWATER CONDITIONS

Information on regional groundwater conditions in the Mendota-Firebaugh area was provided by Davis and Poland (1957) and Belitz and Heimes (1990). Kenneth D. Schmidt and Associates (1997a) provided a report on groundwater conditions in and near the CCID. Kenneth D. Schmidt and Associates (1997b) determined groundwater flows in the San Joaquin River Exchange Contractors service area, which includes most of the study area.

Subsurface Geologic Conditions

The Corcoran Clay is a regional, laterally extensive confining bed beneath much of the west side of the San Joaquin Valley. Regionally, this clay has been used to separate an upper aquifer from an underlying lower aquifer. The focus of this evaluation focuses on groundwater in the upper aquifer, because groundwater in this aquifer is proposed to be pumped. Figure 1 contained in the *Groundwater Flows in the San Joaquin River Exchange Contractors Service Area* (KDSA 1997b) showed depth to the top of the Corcoran Clay. In the area where the proposed pumpage would take place, the top of the Corcoran Clay is an average of about 350 feet deep. Figure 2 of KDSA (1997b) showed the thickness of the Corcoran Clay.

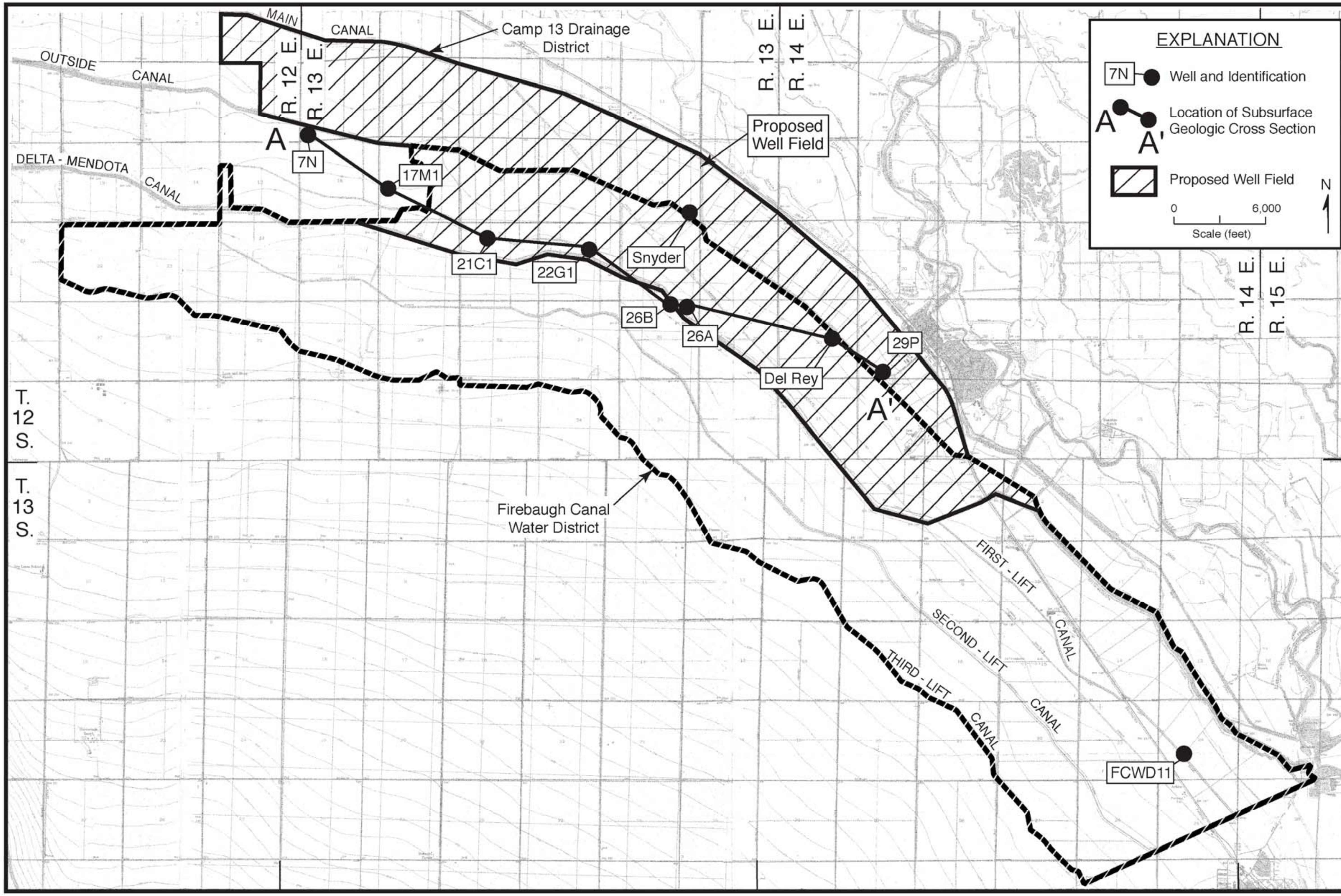

FIGURE 1 - LOCATION OF STUDY AREA, SELECTED WELLS, AND SUBSURFACE GEOLOGIC CROSS SECTIONS

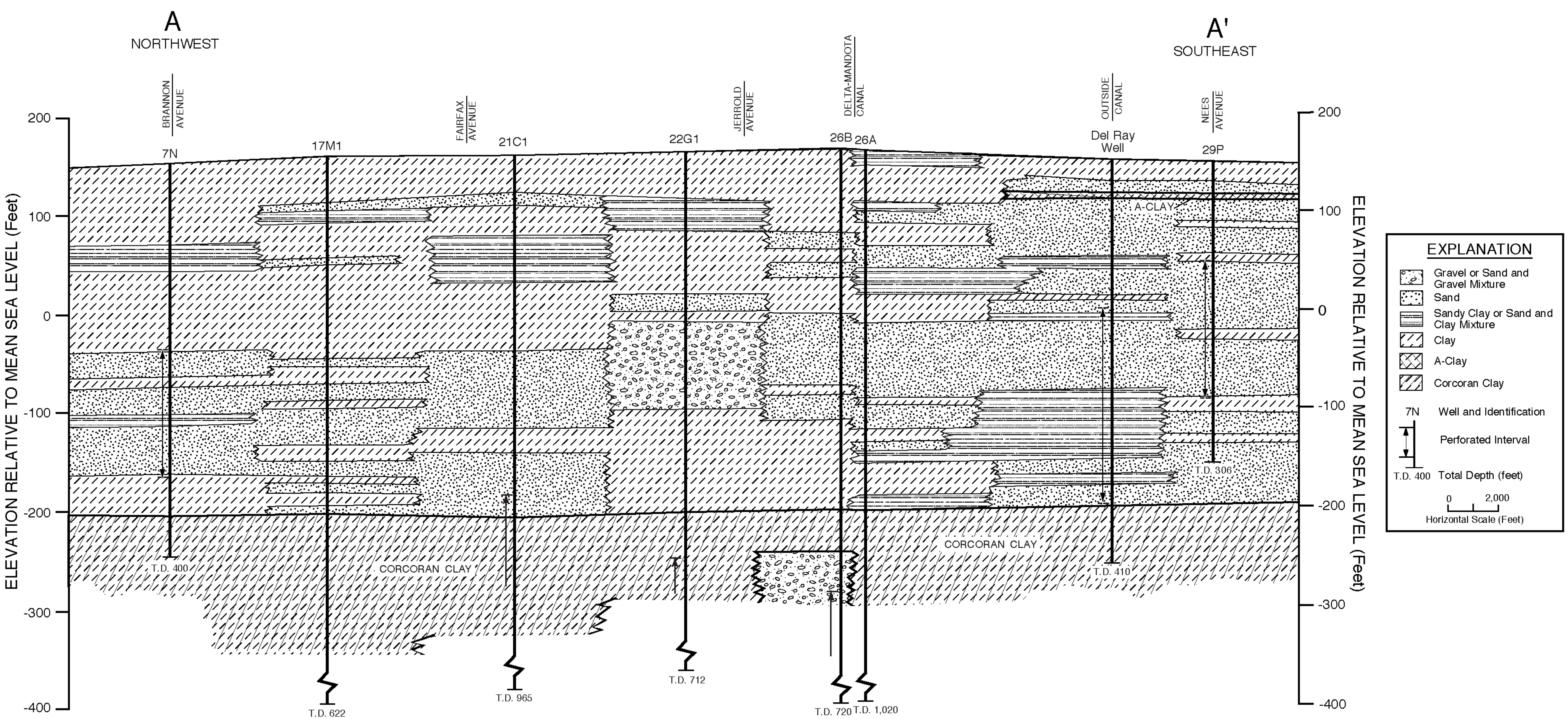

FIGURE 2 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

The clay thickens to the west, and ranges from about 60 to 100 feet thick in most of the study area. Belitz and Heimes (1990) showed that the Sierran Sands are present above the Corcoran Clay and below a depth of about 100 feet near the San Joaquin River near Mendota. These deposits are highly permeable and comprise the major aquifer used in the Firebaugh and Mendota areas. These sands become thinner to the west with increasing distance from the San Joaquin River. The sands are overlain by Coast Range alluvial deposits, which are primarily fine-grained in the study area.

As part of this evaluation, a subsurface geologic cross section was developed (Figure 2), extending from near Brannon Avenue on the west to near Nees Avenue and the Outside Canal on the east. This cross section was developed to focus on conditions above the Corcoran Clay near the area where the proposed pumping is proposed.

A more localized and thinner confining bed is present along the eastern part of the cross section, and this has been termed the A-clay farther south in the Mendota area. The clay is a lacustrine deposit that is overlain and underlain by the Sierran Sands. Near Firebaugh and Mendota, this blue layer is an important confining bed, partially separating groundwater above average depths ranging from about 50 to 70 feet from the underlying groundwater. Coarse-grained water-producing strata (the Sierran Sands) are present beneath about 25 feet of fine-grained deposits near the east end of this cross section. The overlying brown fine-grained deposits (the

Coast Range alluvium) thicken to the west along the section, to about 140 feet near the west. The Sierran Sands are about 325 feet thick near the southeast end of the section and about 120 to 150 feet thick near the northwest end. The southeasterly thickness includes strata above and below the A-clay. The fine-grained Coast Range deposits act to partially confine groundwater in the underlying Sierran Sands. Depth to water in wells tapping these sands is typically about 30 to 40 feet along this cross section. The Del Rey well, shown along this section, was developed as a prototype supply well for the proposed project. The perforations in this well extend from 150 to 350 feet deep, and the well taps the lower part of the Sierran Sands, in order to produce water of a suitable quality (with minimal concentrations of selenium and other trace metals) for the project.

Types and Depths of Wells

Few water supply wells have been completed in most of the FCWD and Camp 13 Drainage District because of the poor groundwater quality and the availability of canal water for irrigation. These wells are either deep wells in the west part of the study area or shallow wells in the east part, as described in the following.

Well completion reports were obtained for about two dozen supply wells in or near the study area. Five of these wells range in depth from about 600 to 710 feet and tap strata below the Corcoran Clay. Most of these deep wells are in the western part of the study area. Most of the remaining supply wells range from about 180 to 390 feet deep and tap strata above the Corcoran Clay. Wells in the City of Firebaugh and CCID wells in the area are generally less than about 250 feet deep. Better quality groundwater has generally been present between about 100 and 250 feet in depth than in other depth intervals in the east part of the study area. Table 1 shows construction data for the Snyder and Del Rey wells (which were used for a pilot pumping program for this project) and a Firebaugh CWD well near Arbios (about a mile northwest of Mendota). All of these wells tap strata above the Corcoran Clay and have been subjected to extended aquifer tests, which are discussed in a later section of this report. Information is also provided for two CCID wells in the area which were subjected to short-term aquifer tests in Fall 1996, and a new City of Firebaugh well, which was pump tested in May 2005.

Water Levels

As part of previous studies for the Exchange Contractors, extensive water-level measurements for wells in the service area were assembled and reviewed (KDSA, 1997b). These records were obtained from the California Department of Water Resources. Water-level hydrographs were then prepared for about 500 wells in 1997. Based on this information, two time periods were selected as representative (Fall 1981 and Spring 1992).

TABLE 1
CONSTRUCTION DATA FOR SELECTED WELLS

Location	Local I. D.	Date Drilled	Total Depth (ft)	Cased Depth (ft)	Perforated Interval (ft)
T12S/R13E-14R	Snyder	10/92	235	230	150-230
-30G	Del Rey	5/02	279	360	150-350
T12S/R14E-29H	City of Firebaugh 14	4/05			115-220
T13S/R14E-2M	CCID 23A				90-180
-24M	FCWD 11	-	-	-	112-247
	CCID 41				86-236

Data from well completion reports.

Upper Aquifer

KDSA (1997b) prepared two water-level elevation and direction of groundwater flow maps for the upper aquifer (above the Corcoran Clay) in the Exchange Contractor’s service area. Figure 3 is a reproduction of the part of the map for Fall 1981 for the study area. This map is considered representative of normal hydrologic conditions. Water-level elevations ranged from greater than 130 feet above mean sea level to the southwest to less than 100 feet above mean sea level to the northeast. A northeasterly direction of groundwater flow was indicated, into Madera County. Some of the shallow groundwater (above a depth of about 70 feet) in the upper aquifer eventually enters tile drainage systems, including in the FCWD and the CCID Camp 13 Drainage District, and is exported from the area. A relatively small amount (about 1,000 acre-feet per year) of groundwater in the upper aquifer in the study area moves downward through the Corcoran Clay and into the lower aquifer (KDSA, 1997b). Most of the groundwater in the upper aquifer that is not pumped southwest of the San Joaquin River flows into Madera County. Hydraulic gradients generally increase to the northeast toward a large depression cone in southwest Madera County.

Figure 4 shows water-level elevations and the direction of groundwater flow in the upper aquifer in Spring 1992. This map is considered typical of drought conditions. A similar direction of groundwater flow is indicted as for Fall 1981. However, hydraulic gradients near the San Joaquin River and in Madera County were steeper in Spring 1992, due to increased pumping associated with the drought.

Figure 5 is a water-level hydrograph for Well T12S/R14E-33Q1 (CCID No. 24), located south of the City of Firebaugh. The well is perforated from 75 to 190 feet in depth and thus taps the upper aquifer. During normal and wet periods, depth to water in this well normally ranged from about 10 to 15 feet. However, during the 1987-93 drought, depth to water was about 15 to 20 feet. Short-term water-level variations were usually less than ten feet. The long-term trend for this well since the late 1970s is one of a constant water level. This is indicated to be a representative trend for the upper aquifer in the area.

Lower Aquifer

KDSA (1990b) provided maps (No. 4 and 5) showing water-level elevations and the direction of groundwater flow in the lower aquifer (beneath the Corcoran Clay) in the Exchange Contractor’s Service Area. A groundwater divide was indicated, generally within about two to three miles of the San Joaquin River. Groundwater in the lower aquifer northeast of this divide was flowing to the northeast into Madera County, and groundwater southwest of this divide was flowing to the southwest, into the Panoche and Westlands Water Districts. Few supply wells in the study area tap the lower aquifer, however many composite wells in southwestern Madera County

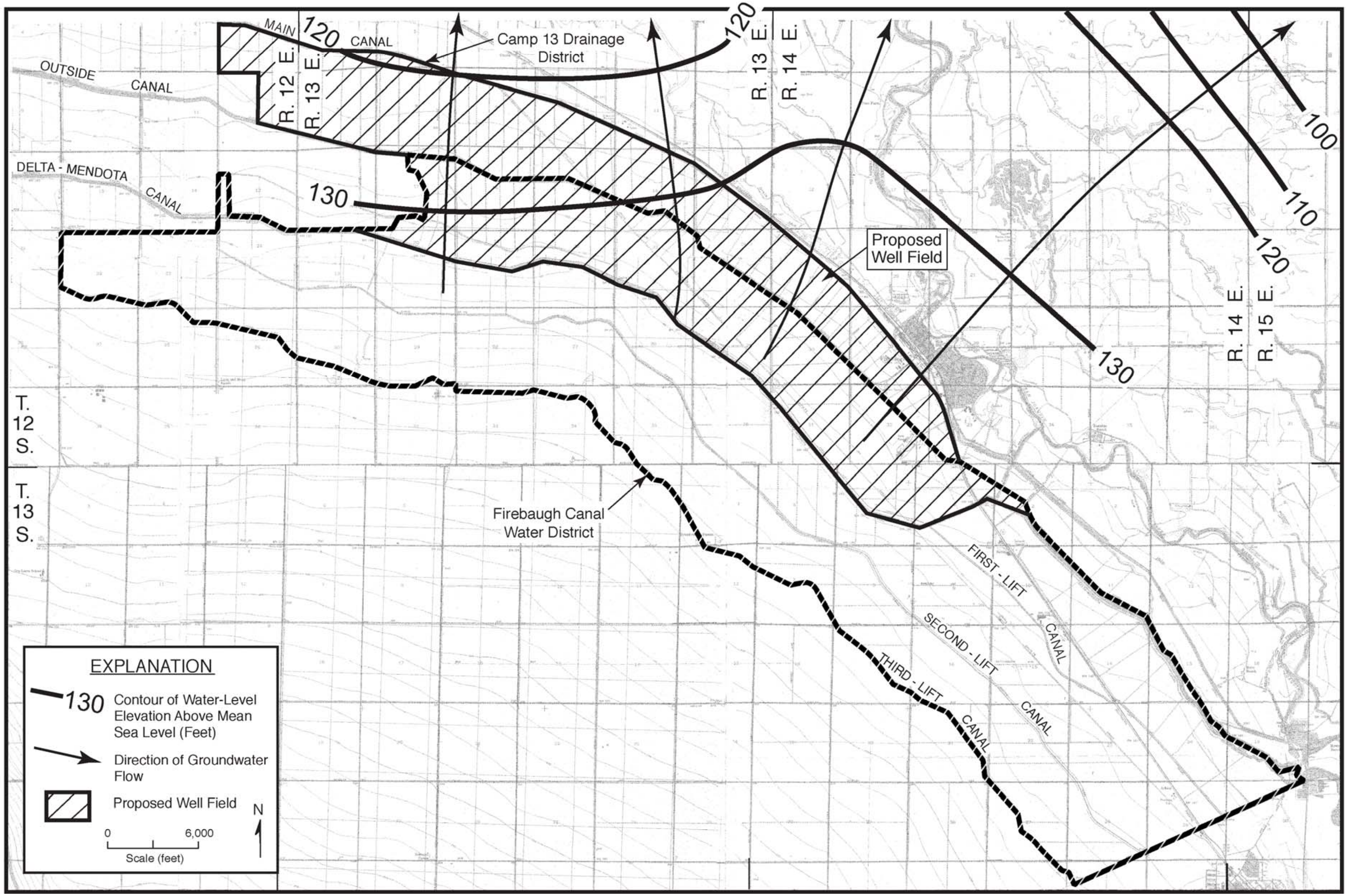

FIGURE 3 - WATER-LEVEL ELEVATION CONTOURS AND DIRECTION OF GROUNDWATER FLOW FOR UPPER AQUIFER (FALL 1981)

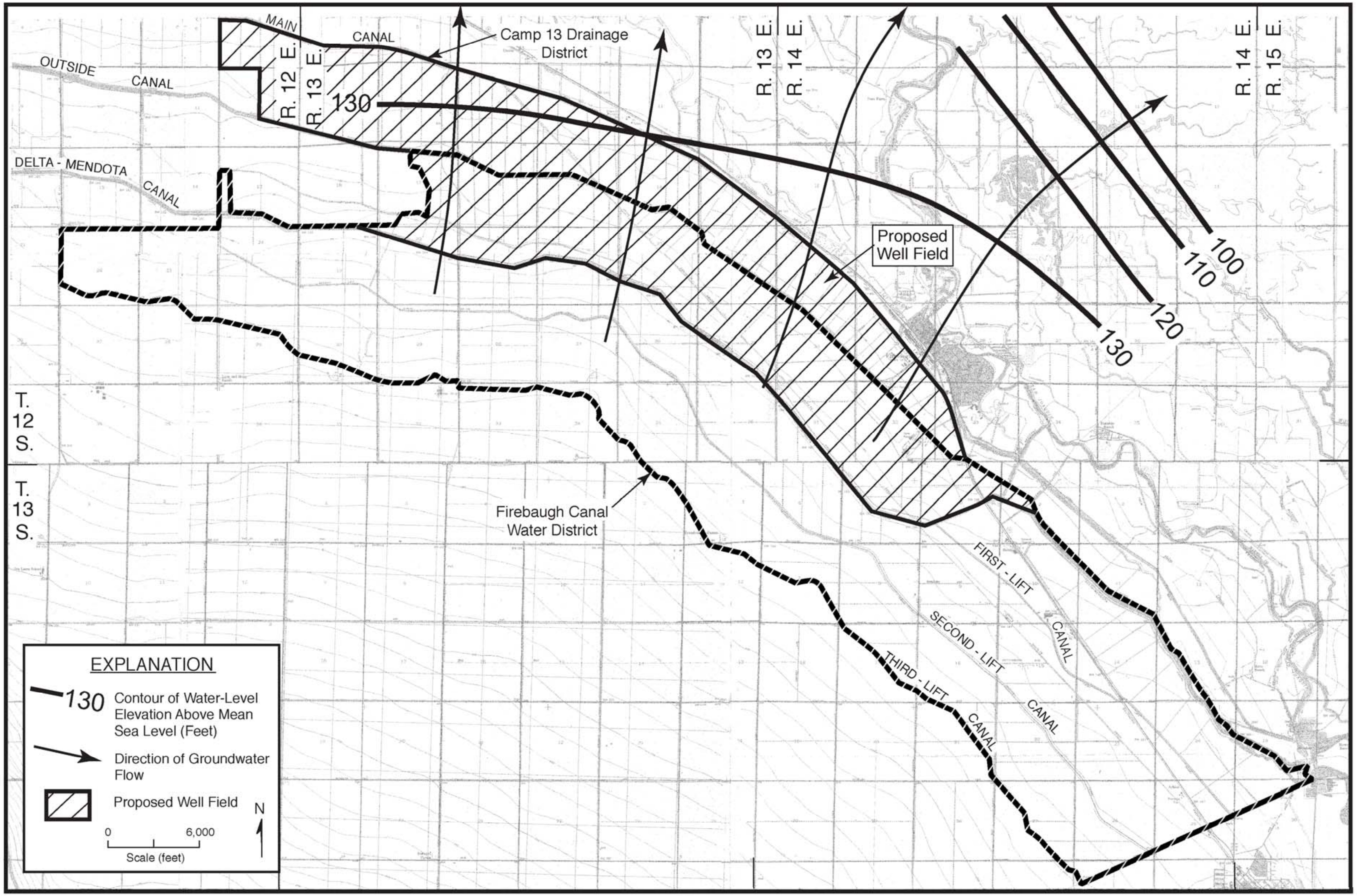

FIGURE 4 - WATER-LEVEL ELEVATION CONTOURS AND DIRECTION OF GROUNDWATER FLOW FOR UPPER AQUIFER (SPRING 1992)

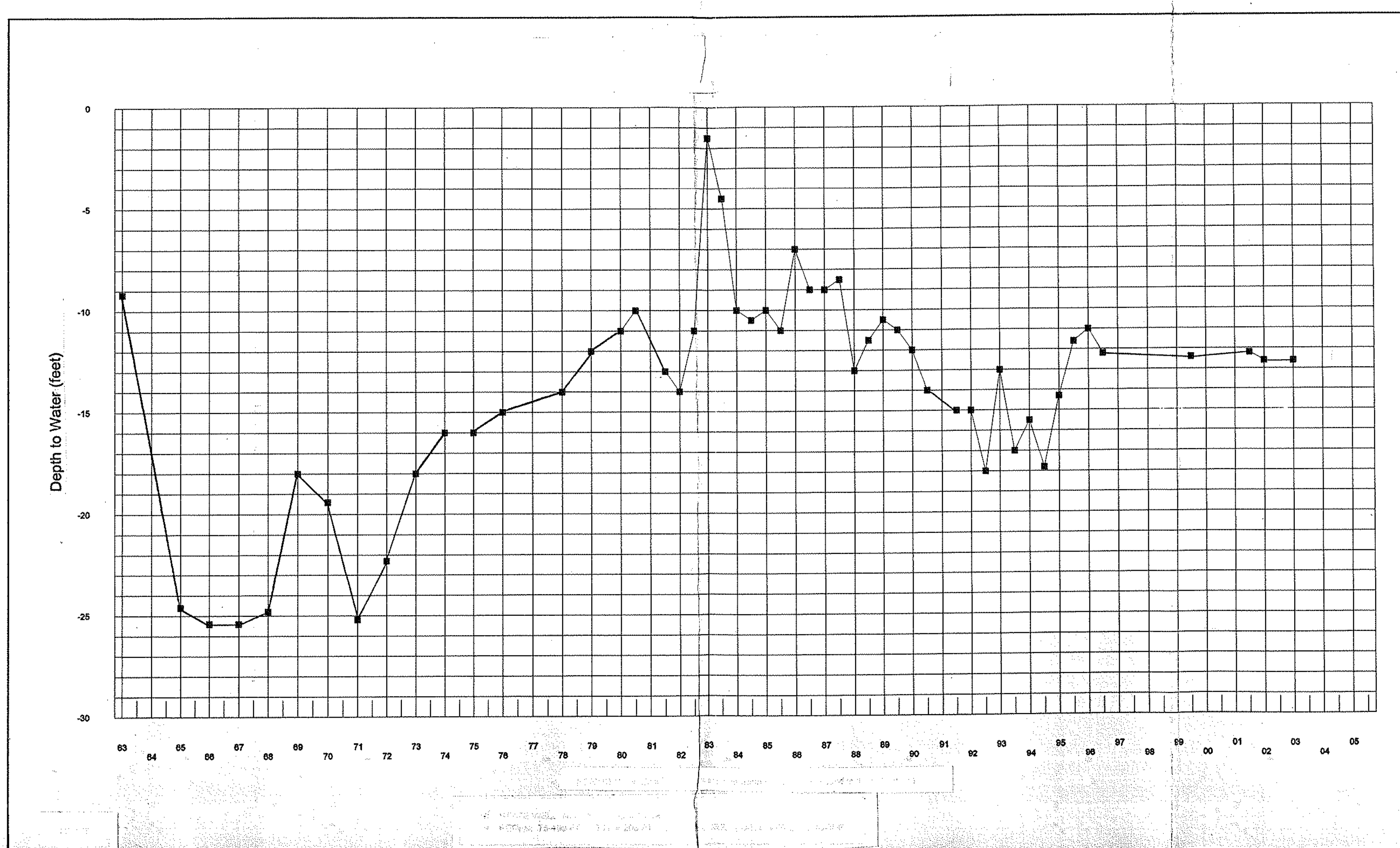

FIGURE 5-LONG-TERM WATER-LEVEL HYDROGRAPH FOR WELL T12S/R14E-33Q1

and most supply wells in the Panoche and Westlands Water Districts tap the lower aquifer. Deeper water-level elevations in some of the composite wells are indicated to be representative of the lower aquifer. Water-level elevations ranged from greater than 70 feet above sea level near the divide to less than 60 feet in Madera County and less than 20 feet in the Panoche and Westland WD in Fall 1981. The source of recharge to groundwater into the lower aquifer is indicated to be downward flow from the upper aquifer. In Spring 1992, the direction of groundwater flow was similar to that in Fall 1981, but water-level elevations were lower in the Panoche and Westlands WD, due to greater pumpage from deep wells at that time compared to in 1981.

Figure 6 of KDSA (1997b) showed water-level or head differences between the upper and lower aquifers in the Exchange Contractors service area in Spring 1992. In the part of the service area south of Highway 152, heads in the upper aquifer are generally always higher than in the lower aquifer. In the study area, these head differences ranged from about 60 feet near Firebaugh to about 130 feet near the southwest boundary of the FCWD. These head differences provide the driving force for the downward flow of groundwater through the Corcoran Clay to the lower aquifer.

Well Production

Yields of large-capacity wells tapping the upper aquifer in the Firebaugh Mendota area commonly range from about 700 to 2,500 gpm.

Table 2 summarizes pumping rates, drawdowns, and specific capacities for wells in the study area that were pumped for aquifer tests. Specific capacities of these wells ranged from 15 to 141 gpm per foot. The lower values probably were influenced by partial plugging of the wells. For example, FCWD Well 11 was unused prior to the test, and had not been in use for many years. Aquifer transmissivities ranged from 78,000 to 446,000 gpd per foot, based primarily on corrected recovery measurements. A transmissivity of 215,000 is considered representative of the upper aquifer in the FCWD and Camp 13 Drainage District.

A 14-day leaky aquifer test was conducted on FCWD Well 11 (T13S/R14E-24M1) near Arbois during December 1988 and January 1989 (KDSA, 1989). This test was done as part of the U.S. Bureau of Reclamation San Joaquin Valley Drainage Program. This well was perforated from 112 to 244 feet in depth and tapped Sierran sands beneath the A-clay. The results of the leaky aquifer test allowed both the storage coefficient for the upper aquifer and the vertical hydraulic conductivity of the A-clay to be determined. A storage coefficient of 0.001 and a vertical hydraulic conductivity of 0.024 gpd per square foot were obtained. It is expected that with longer pumping (i.e., several months or longer), a higher storage coefficient (about 0.01 or greater) would be obtained.

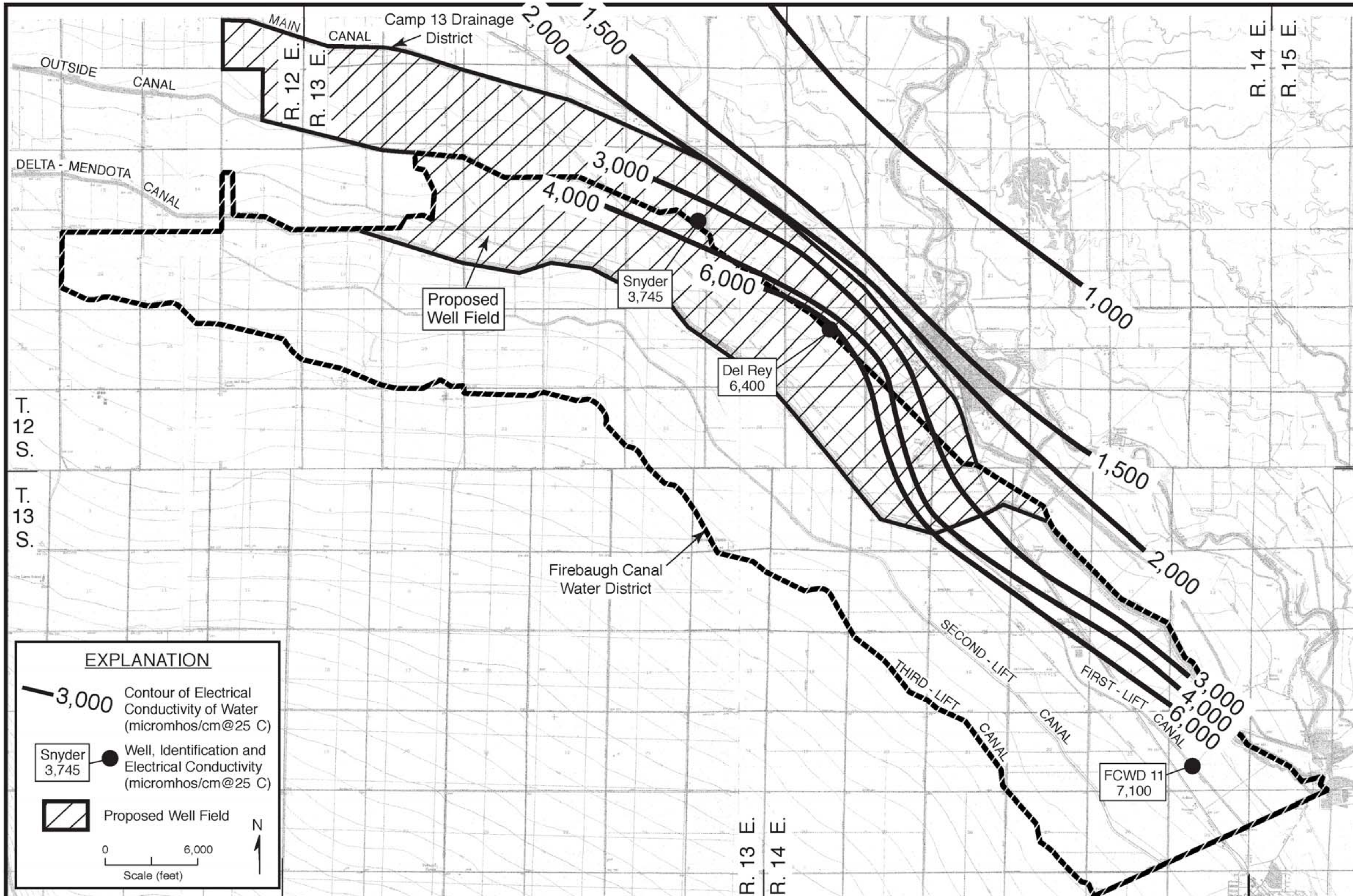

FIGURE 6 - ELECTRICAL CONDUCTIVITY OF WATER FROM WELLS TAPPING UPPER AQUIFER

TABLE 2
WELL PRODUCTION AND AQUIFER CHARACTERISTICS FOR UPPER AQUIFER

Well	Date	Pumping Rate (gpm)	Static Level (ft)	Pumping Level (ft)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)
FCWD 11	1/89	2,210	28.9	84.1	39	200,000
CCID 23A	10/96	2,350	15.9	32	141	446,000
CCID 41	10/96	2,210	16.5	89	30	78,000
Snyder	9/02	1,695	29.5	141.8	15	95,000
Del Rey	9/02	2,820	28.7	63.4	81	257,000
City of Firebaugh 14	5/05	1,000	14.0	32.5	54	87,000

Both of the CCID wells and the City of Firebaugh well were pumped for 24 hours. FCWD Well 11 was pumped for 14 days. The Snyder Well was pumped for about 49 days and the Del Rey Well for about 54 days. Transmissivity values are from corrected recovery measurements, except for the FCWD 11 test. FCWD Well data from KDSA (1989), CCID Well data from KDSA (1991a), Snyder and Del Rey Wells data from HydroFocus, Inc. (2003), and City of Firebaugh Well data from KDSA files.

Groundwater Quality

Upper Aquifer

Some of the most detailed groundwater quality data for the area near and northwest of Mendota were provided by KDSA (1999) in a report for the CCID and the City of Mendota. For the remainder of the study area, information was provided by KDSA (1997a) in a report to the CCID. The quality of groundwater along the east part of the CCID in the study area is influenced by seepage from the San Joaquin River. In much of this area, groundwater is of relatively low salinity and bicarbonate is the major anion. Because DMC water has been used for irrigation of lands in the FCWD and Camp 13 Drainage District for decades, the quality of this water has influenced groundwater quality. This has been due to canal seepage and deep percolation of irrigation return flow. The latter contributes increased salinity to the groundwater due to concentration of salts in the applied water by evapotranspiration. Another important factor has been the northeasterly flow of pour quality groundwater in recent decades.

Figure 29 of KDSA (1997a) showed electrical conductivity values for the upper aquifer in the 1990s. Relatively low electrical conductivity values (less than 1,200 micromhos per centimeter at 25^{o}C) were present in upper aquifer groundwater to the east near the San Joaquin River, from south of Highway 152 to near Mendota. Electrical conductivities exceeded 1,800 micromhos in several areas, including the downslope ends of the west side alluvial fans, including in the study area.

Figure 6 shows electrical conductivity contours for groundwater in the upper aquifer in the study area in recent years. Electrical conductivities were lowest (less than 1,000 micromhos) in the area several miles north of Firebaugh near the San Joaquin River. The 2,000 micromhos electrical conductivity contour is several miles to the southwest, near Highway 33 in the area northwest of Firebaugh and near the Main Canal southeast of Firebaugh. In the Camp 13 Drainage District and FCWD, electrical conductivities were higher to the southwest. Along the Outside Canal west of Firebaugh, electrical conductivities ranged from about 3,700 to 6,400 micromhos in 2002 at the Snyder and Del Rey wells. Near the First Lift Canal north of Arbios, the electrical conductivity was about 5,500 micromhos in 1989. These three wells are thus located in the highest salinity area for groundwater in the Sierran Sands in the study area.

Substantial information is available on the chemical quality of groundwater above a depth of about 100 feet in the study area. This information has been obtained from agricultural drainage monitoring studies over many decades. A number of nested monitor wells have been installed in the study area by the Exchange Contractors, Westland WD, Broadview WD, and other entities. Total dissolved solids (TDS) concentrations were about 11,000 mg/l in groundwater at a depth of about 50 feet at FC-7, near Nees Avenue and the DMC. A TDS concentration of 9,900 mg/l was found in groundwater from a depth of about 50 feet at FC-6, near Herndon Avenue, between the Second and Third Lift Canals. This groundwater is present in oxidized Coast Range deposits above the Sierran Sands, and also contains significant selenium concentrations. That is, selenium concentrations exceed the drinking water standard and fish and wildlife water quality criteria.

Table 3 provides a summary of inorganic chemical analyses of water from the Snyder, Del Rey, and FCESD No. 11 wells. Each of these wells was pumped for an extended period to help determine the impact of pumping groundwater from the Sierran Sands on shallow groundwater levels. TDS concentrations in water from these wells ranged from 2,400 to 5,525 mg/l. Water from the Snyder and Del Rey wells was of the sodium sulfate-chloride type. Sodium concentrations in water from these wells ranged from 600 to 1,100 mg/l, sulfate concentrations from 730 to 1,500 mg/l, and chloride concentrations from 740 to 1,400 mg/l. Boron concentrations in water from these two wells ranged from 1.6 to 2.0 mg/l. Water from FCWD Well No. 11 was of the sodium sulfate type. The sodium concentration was 1,235 mg/l, and the sulfate concentration was 2,980 mg/l. The chloride concentration was 775 mg/l, and the boron concentration was 0.8 mg/l. Selenium concentrations were non-detectable in water from all three of these wells. Arsenic and molybdenum weren’t determined in the sample from FCWD Well 11.

TABLE 3
CHEMICAL QUALITY OF WATER FROM SELECTED WELLS

Constituents (mg/l)	Snyder	Del Rey	FCWD 11
Calcium	110	230	335
Magnesium	79	160	200
Sodium	600	1,100	1,235
Potassium	8	14	8
Carbonate	-	-	<10
Bicarbonate	190	230	226
Sulfate	730	1,500	2,980
Chloride	740	1,400	775
Nitrate	-	-	<0.4
pH	7.5	7.3	7.9
Electrical Conductivity (micromhos @ 25^{o}C)	3,745	6,400	7,100
Total Dissolved Solids (@ 180^{o}C)	2,400	4,300	5,525
Boron	1.6	2.0	0.8
Arsenic	0.001	0.016	-
Molybdenum	0.011	<0.005	-
Selenium	<0.0004	<0.0004	<0.005
Date	8/28/02	8/28/02	12/89
Perforated Interval (ft)	150-230	150-350	112-247

Analyses for the Snyder and Del Rey Wells are by BSK Analytical Laboratory in Fresno and are from HydroFocus, Inc. (2003). Analyses for FCWD Well 11 is from KDSA (1989) and was by BC Laboratories, Inc. of Bakersfield. The FCWD well is south of the area proposed for pumping for this project. Somewhat lower TDS concentrations can be obtained through selective perforating and sealing of new wells.

However, the arsenic concentrations in water from the other two wells ranged from 0.001 to 0.016 mg/l. Molybdenum concentrations in water from these two wells ranged from less than 0.005 to 0.011 mg/l.

Groundwater with TDS concentrations of about 2,500 mg/l can be obtained for the project in the area by selective perforating and sealing of strata when the new wells are constructed.

Lower Aquifer

KDSA (1999) discussed the quality of groundwater below the Corcoran Clay in the Mendota Area. Information on the inorganic chemical quality of groundwater below the Corcoran Clay is available for five test wells and one deep cluster monitor well at the Mendota Airport. TDS concentrations ranged from about 600 to 1,660 mg/l. The lowest TDS concentration was found at a City test well about a mile east of the Fresno Slough, south of the San Joaquin River. The TDS concentrations in water from the samples collected from below the Corcoran Clay in the remaining test wells or monitor wells were 1,000 mg/l or higher. Sulfate concentrations ranged from 115 mg/l to 600 mg/l in water samples from below the Corcoran Clay. Sulfate concentrations in three of four wells sampled for this constituent exceeded the recommended MCL of 250 mg/l. Chloride concentrations in samples from below the Corcoran Clay ranged from 89 to 322 mg/l, and exceeded the recommended MCL in water from two of the wells.

A number of DMC pumpers wells are located along the DMC near Russell Avenue, and tap strata below the Corcoran Clay. Several additional deep wells are located farther east, between Brannon and Fairfax Avenue. Chemical analyses provided by the CCID indicated that these wells have produced water with electrical conductivities ranging from about 1,600 to 1,800 micromhos (equivalent to about 1,100 to 1,200 mg/l of TDS). The salinity of this groundwater thus is similar to that in the area near Mendota.

CONDITIONS UNDER NO ACTION

For the no action alternative, poor quality groundwater in the upper aquifer beneath the Camp 13 Drainage District and FCWD would continue to migrate to the northeast, into adjoining parts of the CCID and Madera County. At some point, other groundwater management activities could be undertaken to partly mitigate this migration, included measures to reduce groundwater overdraft in western Madera County. However, until such activities are undertaken, there may be even more overdraft in the western part of Madera County, due to development of new supply wells for development of previously non-irrigated areas. Groundwater levels are expected to remain shallow in the Camp 13 Drainage District and FCWD, as long as irrigation based on surface water supplies is continued.

POTENTIAL IMPACTS

Drawdowns in Upper Aquifer

In order to determine the drawdown in the upper aquifer (depth interval of about 100 to 350 feet), the Theis Non-Equilibrium Formula was used. Table 4 provides the typical proposed pumpage. Monthly pumpage would range from about 1,000 to 5,000 acre-feet during March-October. The annual pumpage would be 20,000 acre-feet. A maximum of 5,000 acre-feet per month would be pumped during June and July. Each well to be used would be capable of pumping 1,900 gpm. There would be a total of 20 wells, located in the area bounded by the DMC and Main Canals, and Fairfax Avenue and the City of Mendota (Figure 7). Drawdowns were calculated after two months of pumping at the maximum rate of 5,000 acre-feet per month, which is equivalent to about 38,000 gpm. During this period, all 20 wells are assumed to be pumped continuously at 1,900 gpm each. Drawdowns were also calculated for the end of the entire eight-month pumping period. The average pumpage during this period is about 18,600 gpm. For this evaluation, ten of the wells were pumped continuously at 1,900 gpm for eight months.

An aquifer transmissivity of 215,000 gpd per foot and storage coefficient of 0.01 were used to determine drawdowns. The twenty wells were grouped into four groups of wells each to simplify the calculations.

TABLE 4
TYPICAL GROUNDWATER PUMPING SCHEDULE
FOR PROPOSED PROJECT

Month	Pumpage (Acre-Feet)
January	0
February	0
March	1,000
April	2,000
May	2,000
June	5,000
July	5,000
August	3,000
September	1,000
October	1,000
November	0
December	0
Total	20,000

From Central California Irrigation District.

Following the 49-day pumping period for the Snyder Well and the 54-day pumping period for the Del Rey Well in 2002, water levels in the pumped wells recovered within about one day and one and a half days, respectively, to the static levels prior to pumping. Following the 14-day pump test on FCWD Well 11 in 1988/89, the water level in the pumped well completely recovered in one week. This information indicates that full recovery would occur following each season’s pumping.

Calculations indicate that maximum drawdowns in the well field after two months of pumping at the maximum rate would range from about 115 to 125 feet. Experience in the area and water-level records indicate that such drawdowns will not compromise the pumping rates proposed. At the end of the whole pumping period of eight months, drawdowns would be less because of the lower average pumping rate. Drawdowns in the well field would range from about 65 to 90 feet. These calculations are based on the assumption that there is no recharge. Because there is recharge to the upper aquifer, actual drawdowns would be somewhat less than indicated by these calculations.

Calculations indicate that after two months of pumping at the maximum rate, the drawdown would be about 25 feet at a point one mile northeast or downgradient from the northeast edge of the well field, and about 15 feet at a point two miles northeast. After two months of pumping at the maximum rate, the drawdown at a point one mile west of the west boundary of the well field would be about

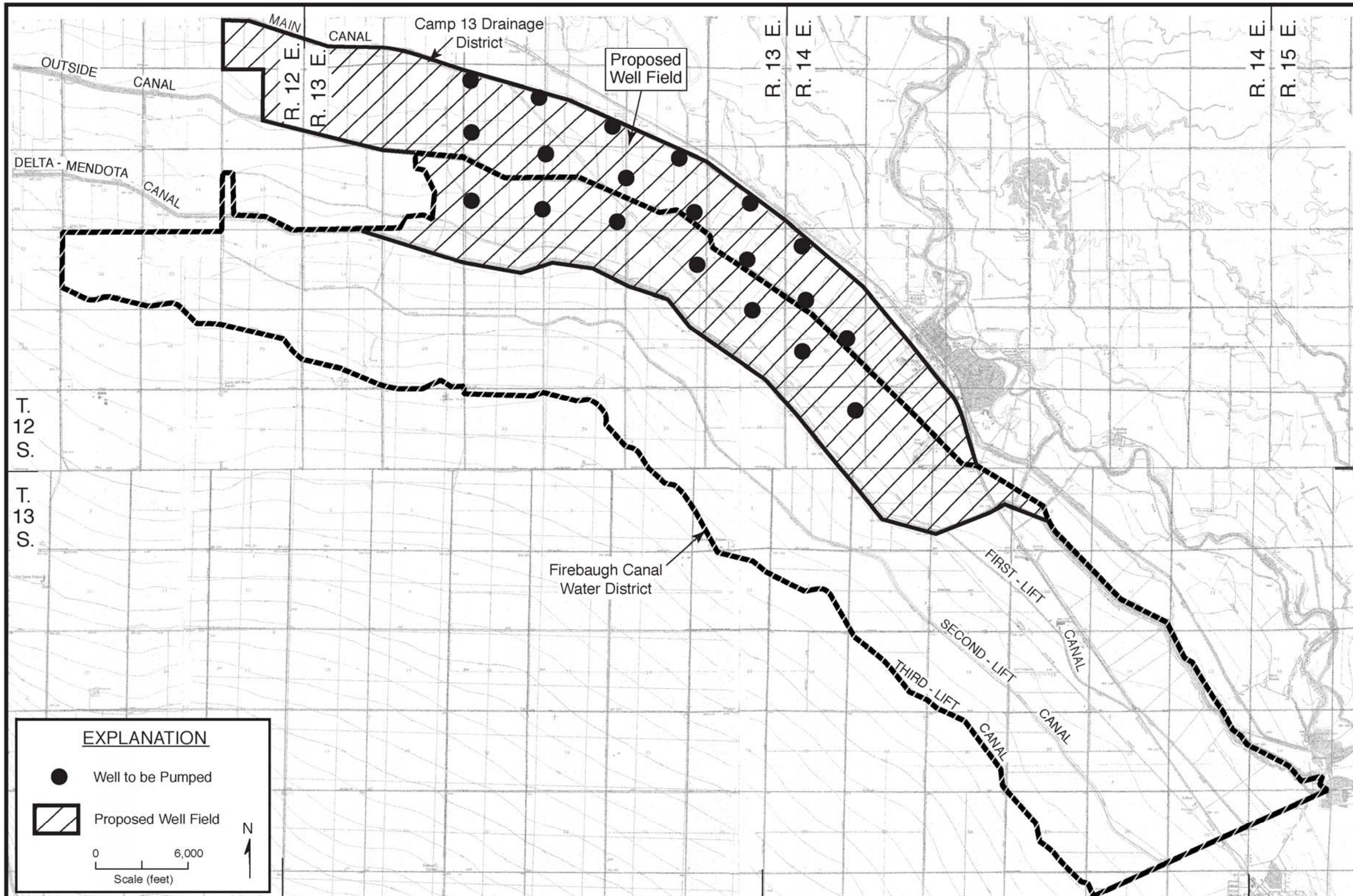

FIGURE 7 - APPROXIMATE LOCATION OF WELLS TO BE PUMPED

30 feet. At a point two miles west, the drawdown would be about 20 feet. Figure 8 shows maximum projected drawdowns in the upper aquifer after two months of pumping.

As part of this evaluation, groundwater inflow into the upper aquifer into the reach where the well field would be constructed was calculated, as well as groundwater outflow to the northeast. The groundwater flows through longer segments in this area were determined by KDSA (1997b). Darcy’s Law was used to estimate groundwater flows, by using values for transmissivity, hydraulic gradients, and width of flow. The hydraulic gradients used in this evaluation were determined from Figures 3 and 4. The transmissivity used was 215,000 gpd per foot. An average of about 5,300 acre-feet per year of inflow was determined for the reach between Fairfax Avenue and Mendota. There was an average of 17,000 acre-feet per year of outflow to the northeast (near the San Joaquin River).

These values are considered accurate within about 15 percent. This increased downgradient flow compared to the upgradient flow is attributed to recharge in the intervening area (FCWD, Camp 13 Drainage District, and San Joaquin River) due to canal seepage, river seepage, and deep percolation of excess applied irrigation water in the area. Pumpage of 20,000 acre-feet per year would thus be enough to control most of the northeasterly flow of poor quality groundwater in this area. This would enhance the quality of the downgradient groundwater in the upper aquifer.

Drawdowns in Shallow Wells

Drawdowns in shallow wells (above a depth of about 20 feet) were determined during each of the three long-term pump tests that were previously discussed. For the FCWD Well 11 test near Arbios, drawdowns of about half a foot were obtained after two weeks of continuous pumping of the well. However, results of the test indicated that these declines (which occurred during a period of no canal flow or irrigation) could be offset due to canal seepage and irrigation in the vicinity. Also, when pumping stopped, the shallow water levels recovered relatively quickly.

For the pump tests on the Snyder and Del Rey Wells, both shallow groundwater levels and drain flows were monitored during the pumping periods. HydroFocus, Inc. (2003) reported on the results of these tests. The water-level trends were influenced by background seasonal water-level declines and irrigation of crops on nearby fields. Drawdowns in shallow observation wells near the Snyder Well ranged from about 0.1 foot at a distance of about 2,000 feet from the pumped well to about 0.6 foot at a distance of several hundred feet. Drawdowns near the Del Rey Well ranged from 0.1 foot or less at a distance of about 2,000 feet from the pumped well to 0.3 foot within a few hundred feet. Small reductions in drain flows were reported, but the evaluation was complicated by background seasonal trends in drain flows, and that the apparent changes in flow were relatively small.

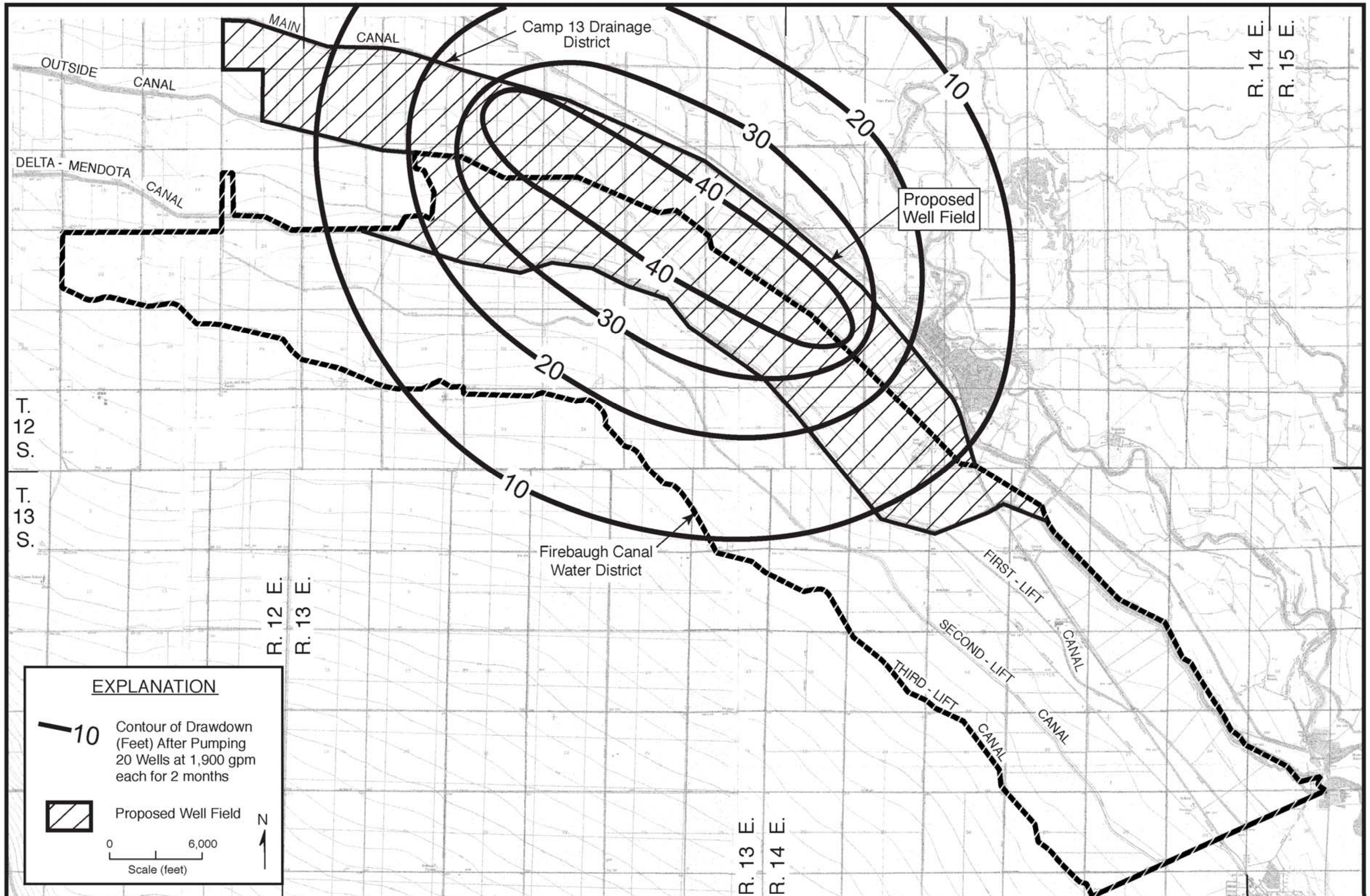

FIGURE 8 - PROJECTED DRAWDOWNS IN UPPER AQUIFER AFTER TWO MONTHS OF MAXIMUM PUMPING

HydroFocus (2003) developed a groundwater model to estimate changes in drain flows due to pumping from the upper aquifer. These model results suggested a reduction in drain flows of about 4.5 acre-feet per 1,000 acre-feet of pumping (approximately the amount pumped from the Snyder and Del Rey Wells during the pilot tests). Belitz and Phillips (1992) predicted a reduction in drain flows of about 8.7 acre-feet per year per 1,000 acre-feet of pumpage from the upper aquifer on an annual basis. The existing drain flow is about 5,000 acre-feet per year in the FCWD and 2,000 acre-feet per year in the Camp 13 Drainage District. For a pumpage of 20,000 acre-feet per year as proposed, the reduction in drain flows would thus appear to be in the range of about 90 to 180 acre-feet per year.

The average spacing between the wells proposed to be pumped would be about 4,500 feet. Based on the results of the pump tests, the projected shallow water-level declines at the end of each pumping season would likely range from about half a foot within several hundred feet of the wells to about 0.2 foot midway between the wells.

Groundwater Flow into Madera County

The previous discussion indicates that about 100 to 200 acre-feet per year of the proposed pumpage would be from reduced drain flows. Another approximately 700 acre-feet per year of pumped water would be from reduced downward flow through the Corcoran Clay, due to decreased downward head gradients. Another several hundred acre-feet per year would be from reduced evaporation of shallow groundwater due to lowered shallow groundwater levels. The remainder of the pumpage (about 19,000 acre-feet per year) would be from decreased outflow of groundwater into other parts of the CCID and Madera County, compared to the present flow. Degradation in groundwater quality in the southwest part of Madera County was discussed in the Madera County Groundwater Management Plan by Todd Engineers (2003). This degradation in the area east of the San Joaquin River was attributed to the easterly migration of poor quality groundwater from the area west of the river.

Under pre-development conditions (i.e., the late 1880s), the trough of the valley (San Joaquin River) was the topographic and hydraulic low spot in the area. Under these conditions, the groundwater in the upper aquifer on both the west and east sides of the river discharged into the river, was consumed by evapotranspiration of native plants, or was evaporated (Belitz and Heimes, 1990). However, with the development of irrigation primarily using surface water supplies in the area west of the river, and the development of previously unirrigated areas in southwestern Madera County to irrigated lands based primarily on groundwater pumping, a northeasterly direction of groundwater flow was developed several decades ago. This has allowed the easterly migration of poor quality groundwater from west of the San Joaquin River to the northeast, in some cases into Madera County. The TDS concentrations of groundwater in much of the area east of the San Joaquin River averages less than 500 mg/l. Such an occurrence has been well documented in the Mendota area, for both City wells west of the Mendota Pool, and a number of CCID wells in the area northwest of Mendota (Luhdorff and Scalmanini and KDSA, 2004).

In order to fully address the degradation of groundwater quality in southwestern Madera County, two combined actions would ultimately be beneficial. The first would be interception of this poor quality groundwater west of the river, which would be done as part of this proposed project. The second would be actions in Madera County to stop the water-level declines or groundwater overdraft, which is largely in undistricted areas north and east of the Columbia Canal Company service area. In order to do this, pumping in that area would have to be reduced or recharge increased. Alternative water supplies would need to be developed to support the existing development.

Land Subsidence

Most of the historic land subsidence on the west side of the San Joaquin Valley due to groundwater pumping was primarily associated with pumping from the lower aquifer (below the Corcoran Clay). A comprehensive subsidence monitoring program was undertaken by the U.S. Geological Survey and U.S. Bureau of Reclamation in the 1950s. Included were a number of compaction recorders and a number of transects (normally roads) along which the land surface elevations were measured. Two of the compaction recorders in the Mendota-Firebaugh area are still operational. One is near the DMC and Russell Avenue, and the other (Yearout Ranch) is east of Mendota near San Mateo Road. As part of the Mendota Pool Group pumping program, another compaction recorder (Fordel) was installed near the Mendota Airport.

Groundwater pumpage near Mendota is primarily from the upper aquifer. Results of monitoring at the Yearout Ranch and Fordel compaction recorders have been discussed in detail in annual monitoring reports by Luhdorff & Scalmanini and KDSA. For pumpage above the Corcoran Clay, most of the monitored subsidence near Mendota has been relatively small (less than 0.05 foot) and has been reversible. That is, the land surface largely rebounds once seasonal pumping stops each year. For the proposed project, pumping water levels would be about the same as historically measured in and near the MPG well fields. Projections indicate that the total irreversible subsidence due to pumping for the project would be less than 0.2 foot. This is relatively small compared to subsidence in the area from deep well pumpage in adjoining areas. Because the pumped wells would be located primarily along or parallel to the DMC and Outside and Main Canals, this subsidence would not have a significant impact on canals or other structures in the area. The reduction in downward flow of groundwater to the lower aquifer (700 acre-feet per year) would be small compared to pumpage from the lower aquifer in adjoining areas.

Groundwater Quality

Because much of the northeasterly migrating poor quality groundwater would be intercepted and exported from the study area, the proposed project would enhance the quality of groundwater downgradient and to the northeast of the Camp 13 Drainage District. This includes groundwater both west of the San Joaquin River and to the east in Madera County. As discussed previously, this northeasterly migration of poor quality groundwater was indicated by Todd Engineers (2003) to be one of the most important groundwater problems in Madera County.

EXISTING MONITORING

Canals

According to the CCID, flows in the Main Canal are measured at the headworks and at a point about three miles downstream. Flows in the Outside Canal are measured at the headworks and near Sierra Avenue. Extensive water quality monitoring is done at the headworks of both canals, where continuous electrical conductivity recorders are operated (Luhdorff and Scalmanini and KDSA, 2005). Periodic sampling of canal water for irrigation suitability and selenium analyses is conducted at the headworks. The CCID also collects monthly samples from 12 sites along the Main and Outside Canals for determination of electrical conductivity, boron, and selenium (analyzed by BSK Analytical Laboratory of Fresno). Once a year, water samples are collected at these locations for irrigation suitability analyses by BSK. One of these sites is at the Main Canal and Russell Avenue, and another is at the Outside Canal and the Panoche Bypass.

Shallow Observation Wells

Shallow observation wells in the project area are generally about 10 to 20 feet deep and are located near section corners. They are thus about a mile apart from each other. The CCID measures water levels in these wells in the Camp 13 Drainage District three times a year (Spring, Summer, and Fall). If enough water is present for sampling, a hand pump is used to collect a water sample. The samples are analyzed by CCID for electric conductivity and boron. For shallow wells in the FCWD, water levels are also measured three times a year.

Drain Sumps

Summers Engineering of Hanford oversees monitoring of drain sumps in the area. There are nine drainage sumps within the Camp 13 Drainage District. These sumps accumulate water from the subsurface tile systems adjacent to the sumps. The sumps discharge into a collection system which ultimately discharges into the Main Drain, located just south of the Main Canal. The water then flows westerly into the Grassland Bypass Project or into the San Joaquin River Quality Improvement Project reuse area. All of these sumps have flowmeters, which are read weekly. Water quality samples are collected approximately monthly and are analyzed for electrical conductivity, selenium, and boron.

CCID Wells

Static water levels are measured in District wells in the spring and fall of each year. Flowmeters are installed on each well to measure pumpage and are read on a monthly basis during pumping episodes. Water samples are normally collected from active District wells annually in the summer for irrigation suitability analyses.

Subsidence

The Russell Avenue recorder is operated by the San Louis-Delta Mendota Canal Water Authority. The Yearout Ranch recorder is operated by the CCID. Land surface elevations and compaction are continuously measured at these two recorders. The Fordel compaction recorder is operated by the Mendota Pool Group. Annual reports prepared by Luhdorff and Scalmanini and KDSA on the MPG pumping program provide information on the subsidence monitoring near Mendota.

PROPOSED MONITORING

The objectives of the monitoring would be to determine impacts of the proposed pumping program on:

1. The quality of downstream canal water.
2. Shallow groundwater levels.

3. Water levels in existing supply wells.

4. Flows in drain sumps.

5. Land surface subsidence.

Canals

Two additional sampling points would be developed for the Main Canal and two more for the Outside Canal. One set would be upstream of the most upstream proposed well discharge into each of the canals. The other set would be downstream of the most downstream proposed well discharge into each of the canals. The same sampling frequency and constituents determined would be used as for the existing program.

Shallow Observation Wells

Measurements for the existing monitoring would continue, except one round of water-level measurements would be made just before pumping starts and another during the last week of pumping.

Drain Sumps

The monitoring for the existing program would continue with no changes.

CCID Wells

The monitoring for the existing program would continue with no changes.

Subsidence

The monitoring for the existing program would continue with no changes.

Project Supply Wells

Flowmeters would be installed on each of these wells and read weekly during the duration of pumping. Static water levels in each well would be measured in the spring and fall, and also just prior to the commencement of pumping from these wells each year. Pumping levels would be measured in these wells on a monthly basis during pumping periods. Water samples would be collected near the end of the peak pumping period from each well for irrigation suitability and selenium analyses. Monthly samples would be analyzed for electrical conductivity. Annual technical reports would be prepared on the results of monitoring, including any necessary revisions in the monitoring program.

SUMMARY OF IMPACT CONCLUSIONS

The most important impact of the proposed action would be a reduction in the northeasterly migration of poor quality groundwater, and a lessening of the deterioration of well water quality in adjoining parts of the existing CCID and in Madera County. Drawdowns would be increased locally during each pumping season, but impacts on pumping lifts in non-SJREC Districts wells would be minimal. Land surface subsidence is also projected to be minimal. The most important impact of the no-action alternative would be a continued northeasterly migration of poor quality groundwater and the resulting degradation of well water quality in adjoining parts of the CCID and in Madera County.

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Appendix B

Air Quality Technical Report

D R A F T

AIR QUALITY TECHNICAL REPORT

for the

San Joaquin River Exchange Contractors Water Authority Groundwater Pumping/Water Transfer Project

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February 3, 2006

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AQCR	Air Quality Control Region
ATCM	Air Toxics Control Measure
ATC	Authority to Construct
BACT	Best Available Control Technology
BARCT	Best Available Retrofit Control Technology
BHP	Brake Horsepower
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DPM	Diesel Particulate Matter
EAC	Early Action Compact
FSOR	Final Statement of Reasons
g/BHP-hr	Grams Per Brake Horsepower Hour
g/KW-hr	Grams Per Kilowatt Hour
HAPS	Hazardous Air Pollutants
KW	Kilowatt
$\mu g/m^3$	Micrograms Per Cubic Meter
mg/m^3	Milligrams Per cubic Meter
MACT	Maximum Achievable Control Technology
NAAQS	National Ambient Air Quality Standards
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NSCR	Non Selective Catalytic Reduction
NSPS	New Source Performance Standards
NSR	New Source Review
O_3	Ozone
Pb	Lead
PM_{10}	Particulate Matter less than 10 microns
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PPM	Parts Per million
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
PTO	Permit to Operate

ACRONYMS AND ABBREVIATIONS continued

SCAQMD	South Coast Air Quality Management District
SCR	Selective Catalytic Reduction
SIP	State Implementation Plan
SJVAB	San Joaquin Valley Air Basin
SJVAPCD	San Joaquin Valley Air Pollution Control District
SOx	Sulfur Oxides
SO_2	Sulfur Dioxide
TSP	Total Suspended Particulate
USC	United States Code
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
VOC	Volatile Organic Compound

AIR QUALITY TECHNICAL REPORT

This report describes ambient air quality in the project area, discusses the affected environment, and summarizes the regulatory setting for air quality. Potential impacts, recommended mitigation measures, and alternatives are also discussed in this section.

The Proposed Action involves the construction of approximately 15 new wells powered by 15 new engines to pump groundwater in the FCWD and Camp 13 area of CCID. The 15 new pumps will be powered by diesel engines up to 150 brake horsepower (BHP) each. Each installation would be located approximately 3,000 to 5,000 feet (0.57 to 0.95 miles) apart in a northwest/southeast trending direction. Five pumps are currently installed on five existing wells and would also operate as part of the Proposed Action.

The No Action Alternative would not develop 20,000 acre feet (AF) of water annually from groundwater pumping. Rather, conservation measures and temporary land fallowing would be used to develop the water. Based on an average value of 3.5 AF of irrigation water required per acre, it is estimated that approximately 3,000 acres of farmland would be fallowed under this alternative. The land fallowed would be rotated among the 28,000 acres such that there would be no land fallowing in the next consecutive eight years of the same acreage. The remaining 25,000 acres in the affected 28,000-acre area would continue in agricultural production. Temporary land fallowing could develop up to 10,500 acre-feet (based on 3 acre-feet/acre on 3,500 acres).

1.0 ENVIRONMENTAL SETTING

The Proposed Action is located in Fresno County, California, near the communities of Firebaugh and Mendota, approximately 30 miles west of the City of Fresno. The surrounding area is currently used for agriculture. Other water development and conveyance activities in the Exchange Contractors Service Area rely primarily on existing electric pumps. Topography and climate affect the level of regional air quality. The relatively long and narrow San Joaquin Valley allows almost no escape for air pollution. The setting of the San Joaquin Valley, coupled with high summer temperatures and inversions that create additional natural barriers to pollution dispersion, creates difficulties in meeting state and Federal air quality standards. In addition, rapid population growth, the presence of two major interstate highways, and a diversity of urban and rural sources have a strong negative impact on regional air quality. With more stringent air quality management regulations, emission levels in the San Joaquin Valley have been decreasing over the past 15 years except for emissions of particulate matter of less than 10 microns in diameter (PM_{10}). Based on the information presented in California Air Resources Board's (CARB) 2002 California Almanac of Emissions and Air Quality (available at http:/www.arb.ca.gov/aqd/aqd.htm), it appears that the downward trend in emission levels is expected to continue. These decreases are predominately due to motor vehicle controls and reductions in evaporative and fugitive emissions. (U.S. Department of the Interior [DOI] 2004)

Air quality in the San Joaquin Valley is not dominated by emissions from one large urban area. Instead, a number of moderately sized urban areas are located throughout the valley. On-road vehicles are the largest contributor to carbon monoxide emissions as well as a large contributor to nitrogen oxide emissions. A large portion of the stationary source reactive organic carbon gas emissions is fugitive emissions from oil and gas production operations. PM_{10} emissions primarily result from paved and unpaved roads, agricultural operations, and waste burning. Engines used in agriculture, both mobile and stationary, also contribute to the San Joaquin Valley's air pollution problem. (U.S. DOI 2004)

The Proposed Action lies entirely within the 8-county San Joaquin Valley Air Basin (SJVAB), which includes San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and western Kern counties. The SJVAB incorporates the same area as the jurisdiction of the San Joaquin Valley Air Pollution Control District (SJVAPCD), encompassing approximately 25,000 square miles. The Proposed Action is located within the San Joaquin Valley Intrastate Air Quality Control Region (AQCR). The AQCRs were established by the Clean Air Act (CAA) and are used by USEPA as a method of dividing the country into regional air basins based on air pollution being a regional problem and not limited to political or state boundaries.

2.0 APPLICABLE REGULATIONS, PLANS AND STANDARDS

2.1 Regulatory Framework

The Proposed Action is to comply with all applicable laws, ordinances, regulations, and standards related to air quality during the construction and operation of the new wells . Applicable laws, ordinances, regulations, and standards, which are summarized below, are not expected to change prior to the completion of this Proposed Action.

2.2 Overview of Standards and Health Effects

The 1970 Clean Air Act (amended in 1977 and 1990) authorizes the U.S. Environmental Protection Agency (USEPA) to promulgate air quality standards for the six (6) criteria air pollutants: ozone (O_3), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulates 10 microns (μm) or less (PM_{10}) and particle size of 2.5 μm or less ($PM_{2.5}$), and sulfur dioxide (SO_2). These standards include primary standards designed to protect public health and secondary standards to protect public welfare, predominately visibility. These National Ambient Air Quality Standards (NAAQS) reflect the relationship between pollutant concentrations and health and welfare effects. California established its own set of ambient air quality standards (CAAQS) for the criteria pollutants, which are more stringent than the NAAQS.

The health effects associated with each pollutant are shown on Table 1. This table also summarizes the state and Federal primary and secondary standards for the six pollutants and the averaging time for determining compliance with the standards.

Regional air basins are designated as either in attainment of the NAAQS or as nonattainment for violating the NAAQS. States or AQCRs that are nonattainment must require control equipment on their stationary sources in order to reduce criteria pollutants.

On April 28, 2005 CARB passed new, stricter standards for ozone. The newly approved standards include:

- A new 8-hour-average standard for ozone at 0.070 ppm, not to be exceeded;
- Retention of the current ozone 1-hour-average standard at 0.09 ppm, not to be exceeded; and
- Retention of the current monitoring method for ozone, which uses the ultraviolet (UV) photometry method, for compliance with the CAAQS for ozone.

Following approval by CARB's Executive Officer, the standards will be adopted and the Final Statement of Reasons or "FSOR", will be completed. ARB anticipated that the adopted standards would go into effect in early 2006, but the existing standards still apply.

On June 15, 2005, USEPA revoked the 1-hour ozone standard for all areas except the 8-hour ozone nonattainment Early Action Compact Areas (EAC) as published in 40 CFR 50.9(b).

Both NAAQS and CAAQS are discussed in more detail below.

Table 1. Summarizes the Federal and California Ambient Air Quality Standards and Attainment Status for the SJVAB

Air Pollutant	State Standard Concentration/ Averaging Time	San Joaquin Valley Air Basin Attainment Status – State	Federal Primary Standard Concentration/ Averaging Time	San Joaquin Valley Air Basin Attainment Status – Federal	Most Relevant Effects
Ozone (O_3)	0.070 ppm (137 µg/m³)*, 8-hr avg. 0.09 ppm, 1-hr. avg. (180 µg/m³)	This standard was approved by the CARB on April 28, 2005 and is expected to become effective in early 2006. Nonattainment/Severe	0.08 ppm, 8-hr avg.** (157 µg/m³) None	Nonattainment/ Serious The Federal 1-hour O_3 standard was revoked by U.S. EPA on June 15, 2005.	(a) Short-term exposures: (1) Pulmonary function decrements and localized lung edema in humans and animals (2) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (b) Long-term exposures: Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (c) Vegetation damage; (d) Property damage
Carbon Monoxide (CO) [portion including Tulare County]	9.0 ppm, 8-hr avg. (10 mg/m³) 20 ppm, 1-hr avg. (23 mg/m³)	Unclassified/ Attainment Unclassified/ Attainment	9 ppm, 8-hr avg. (10 mg/m³) 35 ppm, 1-hr avg. (40 mg/m³)	Attainment	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide ($N0_2$)	0.25 ppm, 1-hr avg. (470µg/m³)	Attainment	0.053 ppm, annual arithmetic mean (100 µg/m³)	Unclassified/ Attainment	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide ($S0_2$)	0.04 ppm, 24-hr avg. (105µg/m³) 0.25 ppm, 1-hr. avg. (655µg/m³)	Attainment Attainment	0.030 ppm, annual arithmetic mean (80 µg/m³) 0.14 ppm, 24-hr avg. (365 µg/m³)	Unclassified Unclassified	(a) Bronchoconstriction accompanied by symptoms which may include wheezing, shortness of breath and chest tightness, during exercise or physical activity in persons with asthma

Table 1 Continued

Air Pollutant	State Standard Concentration/ Averaging Time	San Joaquin Valley Air Basin Attainment Status – State	Federal Primary Standard Concentration/ Averaging Time	San Joaquin Valley Air Basin Attainment Status – Federal	Most Relevant Effects
Suspended Particulate Matter (PM_{10})	20 µg/m^3, annual geometric mean 50 µg/m^3, 24-hr avg.	Nonattainment – In June 2002, CARB established new annual standards for $PM_{2.5}$ and PM_{10}. Nonattainment	50 µg/m^3, annual arithmetic mean 150 µg/m^3, 24-hr avg.	Nonattainment Nonattainment/ Serious	(a) Excess deaths from short-term exposures and exacerbation of symptoms in sensitive patients with respiratory disease; (b) Excess seasonal declines in pulmonary function, especially in children
Particulate Matter ($PM_{2.5}$)	12 µg/m^3, annual arithmetic mean	Nonattainment – In June 2002, CARB established new annual standards for $PM_{2.5}$ and PM_{10}.	15 µg/m^3, annual arithmetic mean 65 µg/m^3, 24-hr avg.	Nonattainment Nonattainment	
Sulfates	25 µg/m^3, 24-hr avg.	Unclassified	None	NA	(a) Decrease in ventilatory function; (b) Aggravation of asthmatic symptoms; (c) Aggravation of cardio-pulmonary disease; (d) Vegetation damage; (e) Degradation of visibility; (f) Property damage
Lead	1.5 µg/m^3, 30-day avg.	Attainment	1.5 µg/m^3, calendar quarter	No designation	(a) Increased body burden; (b) Impairment of blood formation and nerve conduction
Hydrogen Sulfide (H_2S)	0.03 ppm (42 µg/m^3)	Unclassified	None	NA	Severe irritant to eyes and mucous membranes.
Visibility-Reducing Particles	Insufficient amount to reduce the visual range to less than 10 miles at relative humidity less than 70%, 8-hour average (10am – 6pm)	Attainment	None	NA	Visibility impairment on days when relative humidity is less than 70 %

Notes:

** The national 1-hour ozone standard was revoked by U.S. EPA on June 15, 2005.

Parenthetical value is an approximately equivalent concentration.

µg/m^3 = microgram per cubic meter

ppm = parts per million

Source: San Joaquin Valley Air Pollution Control District, Ambient Air Quality Standards & Valley Attainment Status, http://www.valleyair.org/aqinfo/attainment.htm

2.2.1 Federal

The CAA of 1970, 42 USC 7401 et seq. as amended in 1977 and 1990, is the basic Federal statute governing air quality. The provisions of the CAA that are potentially relevant to the Proposed Action are listed below and discussed in the following sections:

- Air Quality Control Regions (AQCR);
- National Ambient Air Quality Standards (NAAQS);

Air Quality Control Regions (AQCR)

Because air pollution is a regional problem and not limited to city, county, or state political boundaries, the CAA established AQCRs as a method of dividing the country into regional air basins. The Proposed Action is located within the San Joaquin Valley Intrastate Air Quality Control Region.

National Ambient Air Quality Standards (NAAQS)

Ambient air quality is protected by Federal and state regulations. Under requirements of the CAA, the USEPA has developed primary and secondary NAAQS for the six (6) criteria air pollutants, including: ozone, NO_2, CO, SO_2, and PM_{10}. Additionally, NAAQS for $PM_{2.5}$ were recently promulgated by the USEPA. The criteria pollutants are described in more detail below. Areas of the country that are currently in violation of NAAQS are classified as nonattainment areas, and new sources to be located in or near these areas are typically subject to more stringent air permitting requirements than similar sources in attainment areas. The NAAQS are codified in 40 CFR Part 50 and summarized in Table 1.

The criteria pollutants and their impact upon health and environmental welfare are discussed in the following subsections.

Ozone Nonattainment Area Classification

On April 15, 2004, the USEPA designated as "nonattainment" areas throughout the country that exceeded the health-based standards for 8-hour ozone. On June 15, 2004, the USEPA issued the final rule to implement the 8-hour Ozone National Ambient Air Quality Standard-Phase I. The phase I final rule sets forth the classification scheme for nonattainment areas and requires states' continued obligations with respect to existing 1-hour ozone requirements. On May 20, 2005, the USEPA took final action on the reconsideration of certain aspects of its final rule to implement Phase 1 of the 8-Hour National Ambient Air Quality Ozone Standard. This action was in response to a Petition for Reconsideration submitted by Earthjustice on behalf of seven environmental organizations.

On June 15, 2005 the 1-hour ozone standard was revoked for all areas except the 8-hour ozone nonattainment Early Action Compact Areas (EAC) areas by virtue of 40 CFR 50.9(b). Due to the revocation of the 1-hour ozone standard, effective June 15, 2005, a recent notice [70 FR 44470] removed from 40 CFR part 81 the 1-hour designations and classifications for all areas except EAC areas that have deferred effective dates for their designations under the 8-hour ozone standard. The former 1-hour ozone designations and classifications as of June 15, 2004, are being retained in subpart C of Part 81 for purposes of the anti backsliding provisions of 40 CFR 51.905. 40 CFR 51.905(c) references subpart C of part 81 for the areas affected by the anti-backsliding regulation.

The final phase 1 rule that implements the 8-hour ozone standard provides generally that only the portion of the designated area for the 8-hour NAAQS that was designated nonattainment for the 1-hour NAAQS is required to comply with the anti-backsliding obligations in 40 CFR 51.905(a). The maintenance plans required under section 51.905(a)(3)(iii) and (4)(ii) must demonstrate maintenance only for the area designated nonattainment (or attainment with a section 175a maintenance plan) for the 1-hour NAAQS at the time of designation of the 8-hour NAAQS.

Ozone (O_3)

Ozone is a photochemical oxidant and the major component of smog. While ozone in the upper atmosphere is beneficial for shielding the earth from harmful ultraviolet radiation from the sun, high concentrations at ground level cause health problems due to lung irritation while eyewatering is symptomatic. Ozone is generated by a complex series of chemical reactions between volatile organic compounds (VOC) and nitrogen oxides (NO_X) in the presence of ultraviolet radiation. High ozone levels result from VOC and NO_X emissions from vehicles and industrial sources, in combination with daytime wind flow patterns, mountain barriers, a persistent temperature inversion, and intense sunlight. For this reason, VOC and NO_X are considered precursors to ozone and are consequently regulated as ozone. The SJVAB did not participate in the EAC and is no longer subject to the 1-hour ozone standard, and is therefore subject to the new 8-hour ozone standard. The SJVAB is currently designated as serious nonattainment for the Federal 8-hour ozone standard.

Nitrogen Dioxide (NO_2)

Nitrogen oxides (NO_X) emissions are primarily generated from the combustion of fuels. NO_X includes nitric oxide (NO) and nitrogen dioxide (NO_2). Because NO converts to NO_2 in the atmosphere over time and NO_2 is more toxic than NO, NO_2 is the listed criteria pollutant. As a gas, it can penetrate deep into the lungs where tissue damage occurs. The control of NO_X is also important because of its role in the formation of ozone. There are currently no attainment designations for the Federal nitrogen dioxide standard.

Carbon Monoxide (CO)

CO is a product of incomplete combustion, principally from automobiles and other mobile sources of pollution. CO emissions from wood-burning stoves and fireplaces can also be measurable contributors. The major immediate health effect of CO is that it competes with oxygen in the blood stream and can cause death by asphyxiation. However, concentrations of CO in urban environments are usually only a fraction of those levels where asphyxiation can occur. Peak CO levels occur typically during winter months, due to a combination of higher emission rates and stagnant weather conditions, such as ground-level radiation inversions. With the exception of the Fresno Urbanized Area (which the project area is not within) all of Fresno County is designated as unclassified/attainment of the Federal CO standard. The SJVAB reached attainment status and the request for redesignation was approved by the CARB on September 24,

1998. The redesignation became final upon action by the California Office of Administrative Law on August 26, 1999.

Sulfur Dioxide (SO_2)

SO_2 is produced when any sulfur-containing fuel is burned. Health and welfare effects attributed to SO_2 are due to the highly irritant effects of sulfate aerosols, such as sulfuric acid, which are produced from SO_2. Natural gas contains trace amounts of sulfur, while fuel oils contain much larger amounts. SO_2 can increase the occurrence of lung disease and cause breathing problems for asthmatics. It reacts in the atmosphere to form acid rain, which is destructive to lakes and streams, crops and vegetation, as well as to buildings, materials, and works of art. The entire project area is designated as attainment for sulfur dioxide. All areas in the state are considered either attainment or unclassified for sulfur dioxide.

Particulate Matter (PM)

Particulates in the air are caused by a combination of wind-blown fugitive or road dust, particles emitted from combustion sources (usually carbon particles), and organic sulfate and nitrate aerosols formed in the air from emitted hydrocarbons, sulfur oxides (SO_X), and NO_X. Particulate matter may contribute to the development of chronic bronchitis and may be a predisposing factor to acute bacterial and viral bronchitis. Respirable particulate matter is referred to as PM_{10}, because it has a diameter size of equal to or less than 10 microns. Respirable particulate can contribute to increased respiratory disease, lung damage, cancer, premature death, reduced visibility, and surface soiling. In 1987, the USEPA adopted standards for PM_{10} and phased out the total suspended particulate (TSP) standards that had been in effect until then. As discussed previously, the USEPA also recently adopted standards for $PM_{2.5}$. Fine particulates come from fuel combustion in motor vehicles and industrial sources, residential and agricultural burning, and from the reaction of NO_X, SO_X and organics. The SJVAB is designated as serious nonattainment for the Federal PM_{10} standard, and is considered in nonattainment with the Federal $PM_{2.5}$ standard.

Lead (Pb)

Lead exposure can occur through multiple pathways, including inhalation of air, and ingestion of lead in food from water, soil, or dust contamination. Excessive exposure to lead can affect the central nervous system. Lead gasoline additives, non-ferrous smelters, and battery plants were historically a significant contributor to atmospheric lead emissions. Legislation in the early 1970s required gradual reduction of the lead content of gasoline over a period of time, which has dramatically reduced lead emissions from mobile and other combustion sources. In addition, unleaded gasoline was introduced in 1975, and together these controls have essentially eliminated violations of the lead standard for ambient air in urban areas. The entire project area is designated as attainment for lead.

2.2.2 State

The California Air Resources Board was created by the Mulford-Carrell Air Resources Act in 1968. CARB's primary responsibilities include: (1) develop, adopt, implement and enforce the state's motor vehicle pollution control program; (2) administer and coordinate the state's air pollution research program; (3) adopt and update the state's ambient air quality standards; (4) review the operations of the local air pollution control districts; and (5) review and coordinate the State Implementation Plans (SIPs) for achieving Federal ambient air quality standards.

State Implementation Plan

The states are required to implement and enforce the NAAQS under a process called SIPs that are approved by the USEPA. Generally the SIPs are comprised of air quality rules that are applicable to stationary sources that may emit criteria pollutants or Hazardous Air Pollutants (HAPs). The original statutory deadline for attainment of the air quality standards was not be met and was extended for California.

The Federal CAA requires each state to prepare a SIP to demonstrate how it will attain the NAAQS within the Federally-imposed deadlines. The CARB reviews the SIP. Local districts adopt new rules under the SIP to achieve attainment of the NAAQS by reducing emissions.

California Clean Air Act

In 1989, California established state ambient air quality standards, including stringent enforcement of the NAAQS and additional standards for visibility reducing particles, sulfates, and hydrogen sulfide. Local districts prepare air quality plans to demonstrate how the ambient air quality standards will be attained. Fresno County must comply with the California CAA. Fresno County, and the entire SJVAB, is in attainment of the state NO_2 and SO_2 standards. The CAAQS and the NAAQS and the health effects associated with each pollutant are shown in Table 1.

Particulate Sulfates

Particulate sulfates are the product of further oxidation of SO_2. Sulfate compounds consist of primary and secondary particles. Primary sulfate particles are directly emitted from open pit mines, dry lakebeds, and desert soils. Fuel combustion is another source of sulfates, both primary and secondary. Secondary sulfate particles are produced when SO_X emissions are transformed into particles through physical and chemical processes in the atmosphere. Particles can be transported long distances. The entire project area is designated as in attainment for the state particulate sulfates standard.

Other State-Designated Criteria Pollutants

Along with sulfates, California has designated hydrogen sulfide (H_2S) and visibility-reducing particles as criteria pollutants, in addition to the Federal criteria pollutants. The entire state is in attainment for visibility-reducing particles. The entire project area is considered unclassified for the hydrogen sulfide standard attainment. (A pollutant is designated unclassified if the data are incomplete and do not support a designation of attainment or nonattainment.) It is also in attainment of the state lead standard.

2.2.3 Local

State law establishes local air pollution control districts (APCDs) and air quality management districts (AQMDs) with the responsibility for regulating emissions from stationary sources. Thus, the SJVAPCD would be the regulating agency for the Proposed Action. The SJVAPCD enforces rules and regulations associated with air quality emissions. The following rules apply to the Proposed Action:

Rule 2010, Permits Required

The SJVAPCD requires that a person shall not build, erect, install, modify, relocate, or replace any emissions unit at a stationary source without first obtaining an Authority to Construct (ATC). The rule also specifies that a person shall not operate, use, or offer for use any emissions unit at a stationary source without first obtaining a Permit to Operate (PTO) or revised PTO which list such emissions unit in its current operating configuration. Rule 4702, discussed below, describes requirements for the engines proposed.

Rule 2040, Applications

Requires the application preparer of an ATC or PTO to provide necessary information and submit a signed statement that certifies the subject equipment complies with all rules and regulations of the SJVAPCD. For PTO applied for under an ATC, the application must certify that the emission unit complies with the provisions of the ATC or, alternatively, lists the differences between the provisions of the ATC and the “as built” emissions unit. Expedited District permit processing is available for compliant applications at a time and materials labor rate of $97.50 per hour in addition to the standard $60.00 per unit application fee.

Rule 2070, Standards for Granting Applications

The SJVAPCD shall deny an ATC or PTO unless the applicant shows that the emissions unit complies with all applicable Federal, state, or local District rules and regulations. The District shall deny a PTO if an emissions unit has not been constructed in accordance with the conditions of the ATC and if the emissions unit as constructed provides less effective air pollution control than specified in the ATC.

Rule 2201, New and Modified Stationary Source Review

The District regulates new sources that emit nonattainment pollutants and their precursors: NO_X, SO_X, VOC, CO, and PM_{10}. Nonattainment pollutants are those air contaminants that do not meet the NAAQS or the CAAQS. Requirements for Best Available Control Technology (BACT) and emission offsets for nonattainment pollutants are the primary provisions of California New Source Review (NSR) rules and regulations.

The San Joaquin Valley is a “severe” nonattainment area for ozone and a “serious” nonattainment area for $PM_{10.}$ Precursors to nonattainment pollutants are also considered nonattainment for regulatory purposes. Therefore, SJVAPCD considers the following pollutants to be nonattainment:

- Oxides of nitrogen (NO_x);
- Oxides of sulfur (SO_x);
- Volatile organic compounds (VOC);

- Carbon monoxide (CO); and
- Particulate matter 10 microns or less (PM_{10}).

Under NSR, there are five (5) specific requirements (tenets) that apply to an applicable permit unit:

- Installing Best Available Control Technology (BACT);
- Obtaining emissions offsets for the proposed increase in emissions over the applicable threshold;
- Providing information to support that the new emission unit would not cause the violation of any ambient air quality standards (i.e., protection of ambient air quality);
- For major sources/modifications, certification of statewide compliance by the applicant; and
- For major sources/modifications, analysis of alternatives.

The regulation applies to all new or modified existing permit units which may cause the issuance of any nonattainment air contaminant or precursors. Major source thresholds are 25 tons/yr or more NO_X or VOC, 100 tons/yr CO, and 70 tons/yr or more PM_{10} or SO_X. Sources below these thresholds and above offset thresholds are nonmajor sources.

Best Available Control Technology: Under the rule, BACT applies to all new or modified existing permit units which may cause the issuance of any individual nonattainment air contaminant (or precursor) in excess of 2 pounds per day (CO attainment area emissions less than 100 tons/yr CO are exempt from BACT).

In general, BACT for subject equipment is independent of any prohibitory rule requirements, i.e., if BACT is more stringent than the rule, BACT supersedes the prohibitory rule. The four (4) tenets of BACT are:

- Achieved in practice;
- Contained in an EPA-approved SIP unless demonstrated unachievable;
- Contained in Federal New Source Performance Standards (NSPS); and
- Technologically feasible and cost-effective.

Typically, cost-effectiveness thresholds set by nonattainment area Districts are set high enough (i.e., at or near the cost of offsets) to support current technology which is achieved in practice as “state-of-the-art”. Therefore, “top down” BACT analysis is typically not applicable in nonattainment areas.

Emission Offsets: Offsets are required for any new or modified source that has the potential to emit 10 tons/year or more of NO_X or VOC, 15 tons/year of CO (100 tons/yr in CO attainment areas), 27.375 tons/yr of SO_X, and 14.6 tons/yr of PM_{10}. Sources below these offset thresholds are small sources. For nonmajor and major sources, offsets are to be provided at the applicable distance ratio:

- Internal offsets (at the same source): 1.0
- Sources less than 15 miles away: 1.2 for nonmajor, 1.3 for major
- Sources 15 or more miles away: 1.5

Protection of Ambient Air Quality: In most cases, dispersion modeling is required to demonstrate that the subject equipment will not cause or make worse a violation of ambient air quality standards.

Certification of Statewide Compliance: Statewide certification of all facilities under common ownership/control is required if the potential to emit is Federally significant: 25 tons/yr NO_X or VOC, 15 tons/yr PM_{10}, or 40 tons/yr SO_X.

Analysis of Alternatives: A CEQA-style project alternatives analysis is required if the potential to emit is Federally significant: 25 tons/yr NO_X or VOC, 15 tons/yr PM_{10}, or 40 tons/yr SO_X.

Also, the rule administratively requires the following:

- Determination of completeness within 30 days of application date;
- Preliminary decision following completeness;
- 30-day public notice and document review period within 10 days of preliminary decision;
- Final action (permit issuance) within 180 days of completeness; and
- Public notice upon final action for major sources and major modifications.

Rule 2520, Federally Mandated Operating Permits

Requires Title V (40 CFR Part 70) operating permits for facilities which:

- Are considered major air toxics (HAPs) sources (10 tons/yr single or 25 tons/yr combined);
- Emit 100 tons/yr or more of any pollutant;
- Are major sources pursuant to area attainment status (i.e. Federally significant);
- Are subject to NSPS (Section 111) or MACT (Section 112) standards;
- Are Title IV (Part 72) acid rain sources (electric utilities);
- Are PSD sources subject to preconstruction review;
- Are solid waste incinerators (Section 111 or 129); and
- Are Special Part 70.3 sources.

Rule 2530, Federally Enforceable Potential to Emit

Exempts sources from Rule 2520 by limiting potential to emit (PTE) to below Title V threshold levels using Federally enforceable permit conditions such as limiting process throughput, equipment derating, etc.

Rule 4701, Internal Combustion Engines – Phase 1

Superseded by Rule 4702 for this Proposed Action.

Rule 4702, Internal Combustion Engines – Phase 2

Implements new EPA Tiered emission standards for stationary IC engines, both spark ignition (gas) and compression ignition (diesel). Emergency engines are exempt, subject to enforceable operating hour limits. Engines used on mobile agricultural equipment are exempt. However, stationary agricultural engines are no longer exempt under the new rule and are subject to NSR.

Subpart 5.1.2 (Table 2 in Rule 4702) sets emission standards for non-certified and certified engines with compliance dates. For a project constructed in calendar year 2006, the rule requires either:

- A Tier 2 engine to be replaced with a Tier 4 engine before January 1, 2015 or 12 years after installation, whichever is later; or
- A Tier 3 or Tier 4 engine (no future replacement required).

Calendar year 2006 is the last sales year for Tier 2 engines in the 75-130 KW (100-175 BHP) range; Tier 3 takes effect in 2007. Therefore, for the Proposed Action, Tier 2 engines could be installed in 2006 and replaced with Tier 4 engines in 2018. However, since project engines would operate a maximum of 3000 hrs/yr, Tier 3 engines may be economically preferable since no future replacement will be required, and the proposed contract ends in 2031.

Per SJVAPCD (see NSR), BACT is independent of Tiered standards implemented by the rule. As shown in the following table, BACT is more stringent than the rule and supersedes the Tiered standards for NO_X and PM_{10}.

In addition to NO_X BACT of 0.15 g/BHP-hr, CARB's Air Toxics Control Measure (ATCM) rule for diesel particulate matter (DPM, as PM_{10}) requires 0.22 g/BHP-hr for agricultural engines in the 100-175 BHP range. Tier 2 and 3 engines conform to this standard. (Nonagricultural engines must meet 0.01 g/BHP-hr under the ATCM rule through the use of add-on particle traps.)

Table 2. USEPA Tier 2 and 3 Standards (75-130 KW, 100-175 BHP)

Emittent	Tier 2 g/kw-hr	Tier 3 g/kw-hr	BACT g/kw-hr	BACT g/bhp-hr
NO_X	5.80	3.50	0.20	0.15
VOC	0.80	0.50	0.50	0.37
CO	5.00	5.00	5.00	3.73
PM_{10} (Tier complies with ATCM)	0.30	0.30	0.30	0.22

Notes:

Tier 2 NO_x + VOC = 6.6 g/KW-hr in combination
Tier 3 NO_x + VOC = 4.0 g/KW-hr in combination

The BACT standard for NO_X requires a 96.6% reduction from Tier 2 and a 94.3% reduction from Tier 3. This can only be accomplished by add-on exhaust controls, i.e., selective catalytic reduction (SCR) for diesels. While nonselective catalytic reduction (NSCR) can be used for spark ignition (gas) engines, the precise lambda (free oxygen) control is problematic for compression ignition applications with only about 80 to 85% reduction of NO_X. SCR uses vaporized 19% aqueous ammonia (ammonium hydroxide, NH_4OH) as a the reducing agent for NO and NO_2 to form nitrogen gas and water vapor :

$$4\ NO + 4NH_3 + O_2 \rightarrow 4\ N_2 + 6\ H_2O$$

$$2\ NO_2 + 4NH_3 + O_2 \rightarrow 3\ N_2 + 6\ H_2O$$

Therefore, in addition to 180 gallons/day diesel fuel, 19% aqua ammonia must be supplied to each engine. To reduce 20 lbs/day NO from a Tier 3 engine, about 9 lb/day ammonia is required, or 47 pounds/day (6 gallons/day) of a 19% solution for a 150 BHP engine.

Estimated emissions for a single and multiple units would be shown in the following tables:

Table 3. Estimated Emissions for Single 150 BHP BACT Engine (3,000 hrs/yr)

Emittent Name	Tier 3 BACT		
	ton/yr	lb/hr	lb/day
Nitrogen Oxides (as NO_2)	0.07	0.05	1.2
Reactive Hydrocarbons (ROC) as CH_4	0.18	0.12	3.0
Carbon Monoxide (CO)	1.85	1.23	29.6
Sulfur Dioxide (SO_2)	0.00	0.00	0.0
Particulates (as PM_{10})	0.11	0.07	1.8
Carbon Dioxide (CO_2)	258.93	172.62	4,143.0

Table 4. Estimated Emissions for Twenty 150 BHP BACT Engines (3,000 hrs/yr)

	Tier 3 BACT		
Emittent Name	**ton/yr**	**lb/hr**	**lb/day**
Nitrogen Oxides (as NO_2)	1.4	1.0	24
Reactive Hydrocarbons (ROC) as CH_4	3.6	2.4	60
Carbon Monoxide (CO)	37	24.6	592
Sulfur Dioxide (SO_2)	0.06	0.03	0.8
Particulates (as PM_{10})	2.2	1.4	36
Carbon Dioxide (CO_2)	5,178.6	3,452.4	82,860

Pursuant to Rule 2201, since BACT emissions would be below offset thresholds, offsets would not be required. If sites are noncontiguous, CO emissions would be below the 100 lb/day public notice threshold for each permitted unit.

3.0 ENVIRONMENTAL IMPACTS AND MITIGATION

Significant air quality impacts from the proposed groundwater pumping/water transfer project could occur if:

a) The project conflicts with or obstructs implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan.

b) The project violates any stationary source air quality standard or contributes to an existing or projected air quality violation.

c) The project results in a net increase of any criteria pollutant for which the project region is non-attainment under an applicable Federal or state ambient air quality standard (including releasing emissions which exceed quantitative threshold for ozone precursors).

d) The project creates or contributes to a non-stationary source “hot spot” (primarily carbon monoxide).

e) The project exposes sensitive receptors to substantial pollutant concentrations.

f) The project creates objectionable odors impacting a substantial number of people.

Only item (c) above regarding a net increase of any criteria pollutant would be applicable to the two Action Alternatives, however, emissions would not have any significant impact on ambient air quality in the vicinity of the Proposed Action.

3.1 Proposed Action

3.1.1 Construction-Related Impacts

Construction for the installation of the 15 wells would generate emissions from the operation of heavy equipment and support vehicles. In addition, fugitive dust may be generated during activities associated with site preparation. Any disturbed soil would be subject to wind entrainment; thus, dust control measures would need to be implemented at the construction sites to minimize off-site deposition of fugitive dust as required by the SJVAPCD and listed in Table 5.

<u>Construction Fugitive Dust Emissions</u>

Fugitive dust (i.e., uncontrolled wind blown particulates) would be generated during construction activities. Dust emissions can vary substantially depending on levels of activity, specific operations, and prevailing meteorological conditions.

Construction operations are assumed to impact the well location footprint and corridor; however, there are no thresholds of significance for fugitive dust. Since the overall area of soil disturbance for water well construction is relatively small (400 square feet per well, 6,000 square feet total), the impact is considered less than significant. The SJVAPCD requires and strongly suggests the implementation of mitigation measures to minimize any impacts from fugitive dust emissions. These measures could be implemented to further reduce impacts.

The SJVAPCD's approach to analyses of construction PM_{10} impacts is to require implementation of effective and comprehensive control measures rather than to require detailed quantification of emissions. It is suggested that agencies electing to quantify emissions do so using either URBEMIS 7G or a report prepared under contract to the South Coast Air Quality Management District (SCAMQD) titled *Improvement of Specific Emission Factors (BACM Project No. 1), Final Report* by Midwest Research Institute, March 29, 1996. These factors may be used at a Lead Agency's discretion. The California Air Resources Board (ARB) indicates that these numbers will be incorporated into the EPA's emission factors document Compilation of Air Pollutant Factors (AP-42).

PM_{10} emissions resulting from construction activities can vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions, and other factors, making quantification difficult. Despite this variability in emissions, experience has shown that there are a number of feasible control measures that can be reasonably implemented to significantly reduce PM_{10} emissions from construction activities. The SJVAPCD has determined that compliance with its Regulation VIII, Fugitive PM_{10} Prohibitions, for all sites and implementation of all other control measures indicated in its *Guide for Assessing and Mitigating Air Quality Impacts* Tables 6-2 and 6-3 would constitute sufficient mitigation to reduce PM_{10} impacts to a level considered less than significant. These mitigation measures for PM_{10} are listed in Table 5. Table 6 shows the emission impact thresholds or guidance identified by SJVAPCD for construction projects.

Typical well-installation activity would include the following types of equipment:

- Diesel-fired Mud Rotary Drill Rig; likely CME-85 or equivalent,
- Diesel-powered support truck, likely F-350 or equivalent;
- Two (2) gasoline-powered Crew Pickup Trucks, likely an F-150 or equivalent; and possibly
- Gas-fired Generator for a Mud Pump.

Emissions from the well installation activity would not be expected to exceed the relevant significance thresholds, and therefore impacts are less than significant. Emission quantification for construction activities is not necessary because emissions from the vehicles (i.e., flatbed truck, forklift or mobile crane) which would initially deliver the pumping engines and SCR equipment to the well sites would contribute a negligible amount of emissions and are not quantified as part of this report.

Table 5. SJVAPCD Mitigation Measures for Construction Emissions of PM_{10}

Regulation VIII Control Measures for Construction Emissions of PM-10 (required for all construction projects)
All disturbed areas, including storage piles, which are not being actively utilized for construction purposes, shall be effectively stabilized of dust emissions using water, chemical stabilizer/suppressant, covered with a tarp or other suitable cover or vegetative ground cover.
All on-site unpaved roads and off-site unpaved access roads shall be effectively stabilized of dust emissions using water or chemical stabilizer/suppressant.
All land clearing, grubbing, scraping, excavation, land leveling, grading, cut & fill, and demolition activities shall be effectively controlled of fugitive dust emissions utilizing application of water or by presoaking.
With the demolition of buildings up to six stories in height, all exterior surfaces of the building shall be wetted during demolition.
When materials are transported off-site, all material shall be covered, or effectively wetted to limit visible dust emissions, and at least six inches of freeboard space from the top of the container shall be maintained.
All operations shall limit or expeditiously remove the accumulation of mud or dirt from adjacent public streets at the end of each workday. *(The use of dry rotary brushes is expressly prohibited except where preceded or accompanied by sufficient wetting to limit the visible dust emissions.) (Use of blower devices is expressly forbidden.)*
Following the addition of materials to, or the removal of materials from, the surface of outdoor storage piles, said piles shall be effectively stabilized of fugitive dust emissions utilizing sufficient water or chemical stabilizer/suppressant.
Within urban areas, trackout shall be immediately removed when it extends 50 or more feet from the site and at the end of each workday.
Any site with 150 or more vehicle trips per day shall prevent carryout and trackout.
Enhanced Control Measures. – Required for implementation at construction sites when required to mitigate significant PM_{10} impacts (in addition to Regulation VIII requirements listed above)
Limit traffic speeds on unpaved roads to 15 mph; and
Install sandbags or other erosion control measures to prevent silt runoff to public
Roadways from sites with a slope greater than one percent.
Additional Control Measures. – Optional control measures strongly encouraged at construction sites that are large in area, located near sensitive receptors, or which for any other reason warrant additional emissions reductions
Install wheel washers for all exiting trucks, or wash off all trucks and equipment leaving the site
Install wind breaks at windward side(s) of construction areas
Suspend excavation and grading activity when winds exceed 20 mph [regardless of windspeed, an owner/operator must comply with Regulation VIII's 20 percent opacity limitation].
Limit area subject to excavation, grading, and other construction activity at any one time.
Use of alternative fueled or catalyst equipped diesel construction equipment
Minimize idling time (e.g., 10 minute maximum)
Limit the hours of operation of heavy duty equipment and/or the amount of equipment in use
Replace fossil-fueled equipment with electrically driven equivalents (provided they are not run via a portable generator set)
Curtail construction during periods of high ambient pollutant concentrations; this may include ceasing of construction activity during the peak-hour of vehicular traffic on adjacent roadways
Implement activity management (e.g. rescheduling activities to reduce short-term impacts)

Table 6. SJVAPCD Construction Emission Thresholds of Significance

Pollutant	Threshold
CO	9 parts per million (ppm) averaged over 8 hours and 20 ppm for 1Hour (20 ppm is equivalent to 150 lbs/hr, 1650 lbs/day or 9900 lbs/wk, and 257 tons/year)
NO_x	10 tons per year
PM_{10}	No quantified threshold, requires mitigation measures (see Table 5)
ROG	10 tons per year

Source: SJVAPCD CEQA Guide for Assessing and Mitigating Air Quality Impacts, January 10, 2002
http://www.valleyair.org/transportation/CEQA%20Rules/GAMAQI%20Jan%202002%20Rev.pdf

3.1.2 Operational-Related Impacts

Tables 3 and 4 present estimated emissions for a single engine and for 20 engines, respectively. The Proposed Action would potentially result in a net increase of criteria pollutants for which the region is non-attainment under Federal or state ambient air quality standards. However, with the implementation of appropriate mitigation, the impacts would be considered less than significant. For this Proposed Action, mitigation is Tier 3 engines with NO_X BACT, as described above.[1]

Vehicles that would deliver diesel fuel for the engines and aqueous ammonia for the SCR equipment would contribute a negligible amount of emission and are not quantified as part of this report.

Screening Air Quality Modeling Methodology and Analysis

The air quality impacts of pump engine emissions were modeled with USEPA's general Gaussian-plume atmospheric dispersion model SCREEN3, version 96043. A unit emission rate of one gram per second (1 g/sec) is used to obtain a normalized result ($\mu g/m^3$) which is then multiplied by estimated emission rates (g/sec) for NO_2, CO, SO_2, and PM_{10} to estimate impacts from the Proposed Action. The distance range is 0.25 miles (400 meters) from a typical remote rural well site.

The screening model predicts expected worst case ambient concentrations for Stability Class D. The model predicts maximum 1-hour impacts ($\mu g/m^3$) and for other regulatory averaging times by multiplying 1-hour average concentrations ($\mu g/m^3$) by correction factors per USEPA guidance (Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised October 1992):

[1] In the event that Tier 2 engines are available and would be installed, appropriate BACT measures would be followed as required for Tier 2 and emissions and screening information would be updated as necessary.

- Three (3) hours: 0.9
- Eight (8) hours: 0.7
- Daily (24) hours: 0.4
- Annual: 0.08

Because SCREEN3 is conservative, it can be used to demonstrate that Tier 3 BACT pump engine emissions would cause no significant impact on ambient air quality in the vicinity of a well site. Table 3 lists the modeled emission rates for a typical well site under the Proposed Action.

Results of the screening analysis are shown in Table 7 where estimated ambient concentrations from pump engine operations are compared to NAAQS at the distance range of 400 meters from a typical well site. For the NAAQS analysis, model-estimated maximum concentrations are added to representative background concentrations to assess compliance with NAAQS. Background air quality data was collected from the nearest air monitoring stations (City of Fresno, 2002-04) to yield values for all pollutants (i.e., NO_2, CO, SO_2, and PM_{10}).

The screening results show that in no case would an individual NAAQS for any pollutant and averaging time be exceeded solely due to emissions from Tier 3 BACT pump engine operation. Proposed Action emissions would not violate any air quality standard or contribute substantially to an existing air quality standard violation (i.e., PM_{10}). There would be no significant air quality impact from operations since none of the significance criteria defined above would be met.

3.1.3 Mitigation

Construction-Related Impacts

The SJVAPCD requires and strongly encourages the implementation of mitigation measures (as listed in Table 5) in order to minimize construction impacts from PM_{10} and fugitive dust emissions. Measures to avoid and/or minimize impacts to air quality should also be included as part of the Proposed Action design and standard construction and operation protocols. The most likely measures are the use of water or chemical stabilizer/suppressant.

Operational-Related Impacts

The new engines would be required to meet BACT requirements as outlined in SJVAPCD Rule 4702. As mentioned previously, the BACT standard for NO_X requires a 96.6% reduction from Tier 2 and a 94.3% reduction from Tier 3, which can only be accomplished by SCR for diesel engines. SCR would be implemented on the engines as BACT mitigation.

Table 7. Tier 3 BACT Emissions Impacts for a Typical Well Site

Criteria Pollutant	Averaging Period	Background Reference	Modeled Maximum $\mu g/m^3$	Background Concentration $\mu g/m^3$	Total Concentration $\mu g/m^3$	State Standard $\mu g/m^3$	Federal Standard $\mu g/m^3$
NO_x (as NO_2)	1-hour max	Fresno 2003	19.7	169	189	470	–
	Annual	Fresno 2003	1.6	14	16	–	100
SO_x (as SO_2)	1-hour max	Fresno 2003	0.6	26	27	655	–
	3-hour	Fresno 2003	0.6	24	25	–	1300
	24-hour	Fresno 2003	0.3	10	10	105	365
	Annual	Fresno 2003	0.1	2	2	–	80
CO	1-hour max	Fresno 2002	493.1	7376	7869	23,000	40,000
	8-hour	Fresno 2002	345.2	5163	5508	10,000	10,000
PM_{10}	24-hour	Fresno 2002	11.8	100	112	50	150
	Annual	Fresno 2002	2.4	40	42	20	50
$PM_{2.5}$	24-hour	Fresno 2002	11.8	100	112	–	65
	Annual	Fresno 2002	2.4	39.6	41.9	12	15

Notes:

Modeled maximum is for an individual well site at a distance of 0.25 miles (400 meters)

Background concentration per SJVAPCD monitoring data (CARB), City of Fresno, 2002-2004

Averaging Period	EPA Factor
3 hours	0.9
8 hours	0.7
24 hours	0.4
Annual	0.08

Reference: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources (Revised) EPA-454/R-92-019, pages 4-16.

3.2 Alternative Action

The Alternative Action would implement other water development methods to prevent the need for pumping groundwater, including canal lining and drip irrigation as well as temporary land fallowing. Approximately 3,000 acres of farmland would be fallowed under this alternative. The land fallowed would be rotated among the 28,000 acres such that the same land would not be fallowed the next consecutive eight years. Large, contiguous blocks of land would not be idled. The remaining 25,000 acres in the affected 28,000-acre area would continue in agricultural production.

Land subject to temporary crop idling is normally disked for weed control or planted with a cover crop, which is subsequently disked. These soil management practices serve to minimize dust, erosion and loss of topsoil, and the development of noxious weeds. In addition, crop idling in the water development area could be offset by reductions in land fallowing in the agricultural areas receiving the water, especially in critical years.

3.2.1 Construction-Related Impacts

There would be no emissions associated with the Alternative Action, as there would be no well-installation activities or pump deliveries, and therefore, no impacts to air quality.

3.2.2 Operational-Related Impacts

There would be no sources of air emissions associated with the operation of the Alternative Action, and the potential use of temporary land fallowing would result in a decrease in emissions from the cessation of agricultural equipment and operations for that land, except for soil management practices to minimize dust, erosion, and loss of topsoil. Fallowed land would be disked for weed control or planted with a cover crop, which is subsequently disked. Consequently, the beneficial impact to air quality is not significant.

3.3 No Action

Under the No Action Alternative, agricultural and municipal and industrial (M&I) water users would receive their CVP contractual supplies subject to the limitations and/or shortages in their contracts with Reclamation using existing conveyance facilities. They would also rely on groundwater pumping to supplement surface water deliveries or obtain water from other sources. Absent the transfer of water, at times the agricultural water users would fallow lands.

Shortages could be expected to occur over the 2006–2031 water service years due to the water year type and CVPIA requirements. Depending on the shortages, either less land would be cultivated due to crop idling on existing acreages or less irrigation water would be applied, resulting in lower production on existing agricultural lands. These changes would be temporary because water year types change from year to year, and land that may have been taken out of production during a dry or critical year could be irrigated during wet or above normal years. Crop idling or land fallowing would occur as necessary under normal land management practices.

At issue is the potential for dust from agricultural operations to contribute to increased suspended particulate matter. Land subject to temporary crop idling (due to water supply shortages) is normally disked for weed control or planted with a cover crop, which is subsequently disked. These soil management practices serve to minimize dust, erosion and loss of topsoil, and the development of noxious weeds. Therefore, no change would occur to air quality under No Action Alternative, and existing conditions represent reasonably expected future conditions. The No Action Alternative would have no impacts to air quality in the project area.

4.0 Cumulative Impacts

Proposed Action

A cumulative impact analysis takes into consideration impacts which may be created as a result of combining the Proposed Action with other related programs or projects that have impacts. At issue is whether there is a considerable cumulative effect on air quality. A cumulative impacts analysis based on a list of other projects in the area (such as urban development and farming operations) would not be appropriate in an area where attaining air quality standards has proved challenging. Although the Proposed Action's incremental impacts from the installation and operation of groundwater wells and pumps are individually limited, could they be considered cumulatively considerable? The conclusion is that they are not cumulatively considerable as explained below.

The topographical and climatologic conditions of San Joaquin Valley causes the region to have difficulty meeting state and Federal air quality standards (Section 1.0). Due to strict air quality management regulations, emission levels in the San Joaquin Valley have decreased over the past 15 years with the exception of PM_{10}, and indicators predict that the downward trend in emission levels will continue. These decreases are predominately due to motor vehicle controls and reductions in evaporative and fugitive emissions. (U.S. DOI 2004). However, the project area is still not in attainment with state and Federal air quality standards including ozone and particulate matter, and is designated as a severe nonattainment area.

For this Proposed Action by the Exchange Contractors, it is necessary to view the project's small insignificant impacts in a regional context of past, present, and future projects. With regard to air quality, there are two sources of emissions that would be created with the Proposed Action. The first source is combustion and dust emissions from the installation of the 15 new wells. The second source is the operation of the 15 new and five existing diesel-fired engines. As discussed in Sections 3.1.1 and 3.1.2, it is not expected that either source of emissions would result in significant impacts.

Based on the existing air quality conditions in the project area, the Proposed Action would have an incremental contribution to a cumulative effect. However, that contribution would not be cumulatively considerable based on the fact that the project would comply with "specific requirements in a previously approved plan…" (Remy et al 1999). As required by the CAA, the SJVAPCD must develop attainment plans to demonstrate how they will comply with the standards for which they are nonattainment (PM and ozone). Subsequently, the District must propose and approve air quality regulations to address the pollution problems identified in the required attainment plans. The USEPA approved the 2003 PM_{10} Plan for the San Joaquin Valley. The approval by the USEPA helps to facilitate the emission reductions as proposed in the attainment plan. The current plan for ozone attainment is the 2002-2005 Rate of Progress Plan for San Joaquin Valley Ozone. A 2004 Extreme Ozone Plan was submitted to EPA in November 2004 and is currently under review. Consequently, **the incremental contribution of the Proposed Action to air quality problems in the region would not be cumulatively**

considerable based on the project's compliance with the SJVAPCD rules that are included as part of the ozone and PM attainment plans.

Alternative Action

The Alternative Action would not result in any combustion emissions and therefore would not be cumulatively considerable to air quality in the region.

5.0 REFERENCES

Remy, Michael et. al. Guide to the California Environmental Quality Act (CEQA). October 1999. Solano Press Books. Point Arena, California.

San Joaquin Valley Air Pollution Control District, Ambient Air Quality Standards & Valley Attainment Status, http://www.valleyair.org/aqinfo/attainment.htm

San Joaquin Valley Air Pollution Control District CEQA Guide for Assessing and Mitigating Air Quality Impacts, January 10, 2002,

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South Coast Air Quality Management District, *Improvement of Specific Emission Factors (BACM Project No. 1), Final Report* by Midwest Research Institute, March 29, 1996.

U.S. Department of the Interior [DOI], Bureau of Reclamation, and San Joaquin River Exchange Contractors Water Authority, *Final EIS/EIR, Water Transfer Program for the San Joaquin River Exchange Contractors Water Authority 2005-2014*, December 2004.

U.S. Environmental Protection Agency. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources (Revised) EPA-454/R-92-019, pages 4-16.

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Appendix C

Biological Resources

Attachment C-1

Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS			
San Mateo thorn-mint *Acanthomintha duttonii*	FE, CSC, CNPS 1B	Chaparral, valley and foothill grassland, coastal scrub. Endemic to San Mateo County. Extant populations only known from very uncommon serpentinite vertisol clays; in relatively open areas. 50-200 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Franciscan onion *Allium peninsulare var. franciscanum*	CNPS 1B	Cismontane woodland, valley and foothill grassland. Clay soils; often on serpentine. Dry hillsides. 100-300 meters.	No habitat in project area.
Sharsmith's onion *Allium sharsmithae*	CNPS 1B	Chaparral, cismontane woodland, serpentine, rocky substrates, 400–1,200 meters. Alameda, Santa Clara and Stanislaus Counties	Occurs in vicinity of potential water recipient use. No potential effect.
bent-flowered fiddleneck *Amsinckia lunaris*	CNPS 1B	Cismontane woodland, valley and foothill grassland. 50-500 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
forked fiddleneck *Amsinckia vernicosa* var. *furcata*	CNPS 4	Cismontane woodland, valley and foothill grassland. Often on shale outcrops in disturbed, rather open sites. Often in gypsum-affected soils. 50-1,000 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Santa Cruz manzanita *Arctostaphylos andersonii*	CNPS 1B	Broadleaved upland forest, chaparral, north coast coniferous forest. Known only from the Santa Cruz Mountains. Open sites, redwood forest. 180-800 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Pajaro manzanita *Arctostaphylos pajaroensis*	CNPS 1B	Chaparral, sandy soils, 30-760 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Kings Mountain manzanita *Arctostaphylos regismontana*	CNPS 1B	Broadleaved upland forest, chaparral, north coast coniferous forest. Endemic to Santa Cruz and San Mateo Counties. Granitic or sandstone outcrops. 305-730 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Bonny Doon manzanita *Arctostaphylos silvicola*	CNPS 1B	Chaparral, closed-cone coniferous forest, lower montane coniferous forest. only known from zayante (inland marine) sands in Santa Cruz County. 120-390 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
alkali milk-vetch *Astragalus tener var. tener*	CNPS 1B	Alkali playa, valley and foothill grassland, vernal pools. Low ground, alkali flats, and flooded lands; in annual grassland or in playas or vernal pools. 1-170 meters.	No habitat in project area.
heartscale *Atriplex cordulata*	CNPS 1B	Chenopod scrub, valley and foothill grassland, meadows. Alkaline flats and scalds in the Central Valley, sandy soils. 1-150(600)m.	No habitat in project area.
brittlescale *Atriplex depressa*	CNPS 1B	Chenopod scrub, meadows, playas, valley and foothill grassland, vernal pools. Usually in alkali scalds or alkaline clay in meadows or annual grassland; rarely associated with riparian, or marshes. 1-320 meters.	No habitat in project area.
San Joaquin spearscale *Atriplex joaquiniana*	CNPS 1B	Chenopod scrub, alkali meadow, valley and foothill grassland. In seasonal alkali wetlands or alkali sink scrub with *Distichlis spicata*, *Frankenia*, etc. 1-250 meters.	No habitat in project area.
lesser saltscale *Atriplex minuscula*	CNPS 1B	Chenopod scrub, playas, valley and foothill grassland. Known from a handful of sites; historically in San Joaquin Valley in alkali sink and grassland in sandy, alkaline soils. 20-100 meters.	No habitat in project area.
vernal pool smallscale *Atriplex persistens*	CNPS 1B	Vernal pools. Alkaline vernal pools. 10-115 meters	No habitat in project area.
subtle orache *Atriplex subtilis*	CNPS 1B	Valley and foothill grassland. Little info available. 40-100 meters.	No habitat in project area.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Lost Hills crownscale *Atriplex vallicola*	CNPS 1B	Chenopod scrub, valley and foothill grassland, vernal pools. In powdery, alkaline soils that are vernally moist with *Frankenia*, *Atriplex* species and *Distichlis*. 0-605 meters.	No habitat in project area.
big-scale (=California) balsamroot *Balsamorhiza macrolepis var macrolepis*	CNPS 1B	Valley and foothill grassland, cismontane woodland. Sometimes on serpentine. 35-1000 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
chaparral harebell *Campanula exigua*	CNPS 1B	Chaparral. rocky sites, usually on serpentine in chaparral. 300-1250 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Mt. Hamilton (=Sharesmith's) harebell *Campanula sharsmithiae*	CNPS 1B	Chaparral. Only known from Santa Clara and Stanislaus Counties. Serpentine barrens. 480-1820 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
bristly sedge *Carex comosa*	CNPS 2	Marshes and swamps. Lake margins, wet places; site below sea level is on a delta island. -5-1,005 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Tiburon paintbrush *Castilleja affinis* ssp. *neglecta*	FE, CT, CNPS 1B	Requires serpentine soil, endemic to the San Francisco Bay are - Marin, Napa and Santa Clara Counties. A perennial herb that blooms April–June.	Occurs in vicinity of potential water recipient use. No potential effect.
pink creamsacs *Castilleja rubicundula* ssp. *rubicundula*	CNPS 1B	Chaparral, meadows and seeps, valley and foothill grassland. Openings in chaparral or grasslands. On serpentine. 20-900 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
California jewel-flower *Caulanthus californicus*	FE, CE, CNPS 1B	Chenopod scrub, valley and foothill grassland, pinyon juniper woodland. Historical from various valley habitats in both central v. And carrizo plain. 65-900 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Lemmon's jewelflower *Caulanthus coulteri* var *lemmonii*	CNPS 1B	Pinyon-juniper woodland, valley and foothill grassland. 80-1,220 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Coyote ceanothus *Ceanothus ferrisiae*	FE, CSC, CNPS 1B	Chaparral, valley and foothill grassland, coastal scrub. Endemic to Santa Clara County. Serpentine sites in the Mt. Hamilton range. 120-455 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Congdon's tarplant *Centromadia parryi* ssp. *congdonii*	CNPS 1B	Valley and foothill grassland. Alkaline soils, sometimes described as heavy white clay. 1-230 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Ben Lomond spineflower *Chorizanthe pungens* var. *hartwegiana*	FE, CE, CNPS 1B	Lower montane coniferous forest. Endemic to the ben lomond sands of Santa Cruz County. Zayante coarse sands in maritime ponderosa pine sandhills. 120-470 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Monterey spineflower *Chorizanthe pungens* var. *pungens*	FE, CT, CNPS 1B	Coastal dunes, chaparral, cismontane woodland, coastal scrub. Only known from Monterey and Santa Cruz Counties. Sandy soils in coastal dunes or more inland within chaparral or other habitats. 0-150 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Scotts Valley spineflower *Chorizanthe robusta* var. *hartwegii*	FE, CSC, CNPS 1B	Meadows, valley and foothill grassland. Known only from one extended population in Scotts Valley, Santa Cruz County. In grasslands with mudstone and sandstone outcrops. 230-245 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
robust spineflower *Chorizanthe robusta* var. *robusta*	FE, CSC, CNPS 1B	Cismontane woodland, coastal dunes, coastal scrub. Sandy terraces and bluffs or in loose sand. 3-120 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Mt. Hamilton thistle *Cirsium fontinale* var. *campylon*	CNPS 1B	Cismontane woodland, chaparral, valley and foothill grassland. In seasonal and perennial drainages on serpentine. 95-890 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
lost thistle *Cirsium praeteriens*	CNPS 1A	Little information exists on this plant; it was collected from the Palo Alto area at the turn of the 20th century. Although not seen since 1901, this *Cirsium* is thought to be quite distinct from other *Cirsiums* according to D. Keil. 0-100 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
South Bay clarkia (=Santa Clara red ribbons) *Clarkia concinna* ssp. *automixa*	CNPS 4	Cismontane woodland, chaparral. On slopes and near drainages. 90-970 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
San Francisco collinsia *Collinsia multicolor*	CNPS 1B	Closed-cone coniferous forest, coastal scrub. On decomposed shale (mudstone) mixed with humus. 30-250 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
hispid bird's-beak *Cordylanthus mollis* ssp. *hispidus*	CNPS 1B	Meadows, playas, valley and foothill grassland. In damp alkaline soils, especially in alkaline meadows and alkali sinks with *Distichlis*. 10-155 meters.	No habitat in project area.
palmate-bracted bird's-beak *Cordylanthus palmatus*	FE, CE, CNPS 1B	Chenopod scrub, valley and foothill grassland. Usually on Pescadero silty clay which is alkaline, with *Distichlis*, *Frankenia*, etc. 5-155 meters.	Potential habitat in project area. Occurs in vicinity of potential water recipient use (SLU). No potential effect.
Mt. Hamilton coreopsis *Coreopsis hamiltonii*	CNPS 1B	Cismontane woodland. Only known from Santa Clara and Stanislaus Counties. On steep shale talus with open southwestern exposure. 530-1,300 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Hall's tarplant *Deinandra halliana*	CNPS 1B	Cismontane woodland, chenopod scrub, valley and foothill grassland. Reported from a variety of substrates including clay, sand, and alkaline soils. 300-950 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
interior California (Hospital Canyon) larkspur *Delphinium californicum* ssp. *interius*	CNPS 1B	Cismontane woodland, chaparral. In wet, boggy meadows, openings in chaparral and in canyons. 225-1,060 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
recurved larkspur *Delphinium recurvatum*	CNPS 1B	Chenopod scrub, valley and foothill grassland, cismontane woodland. Many historical and degraded sites. On alkaline soils; often in valley saltbush or valley chenopod scrub. 3-685 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
western leatherwood *Dirca occidentalis*	CNPS 1B	Broadleafed upland forest, chaparral, closed-cone conifer forest, cismontane woodland, north coast conifer forest, riparian forest, riparian woodland. On brushy slopes; mostly in mixed evergreen and foothill woodland communities. 30-550 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Santa Clara Valley dudleya *Dudleya setchellii*	FE, CSC, CNPS 1B	Valley and foothill grassland, cismontane woodland. Endemic to serpentines of Santa Clara County. On rocky serpentine outcrops and on rocks within grassland or woodland. 80-335 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
four-angled spikerush *Eleocharis quadrangulata*	CNPS 2	Marshes and swamps. Freshwater marshes, lake and pond margins. 20-500 meters.	No habitat in project area.
Brandegee's eriastrum *Eriastrum brandegeeae*	CNPS 1B	Chaparral, cismontane woodland. On barren volcanic soils; often in open areas. 345-1,000 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Hoover's eriastrum (= woolly-star) *Eriastrum hooveri*	CNPS 4	Chenopod scrub, valley and foothill grassland, pinyon and juniper woodland. On sparsely vegetated alkaline alluvial fans; also in the temblor range on sandy soils. 50-915 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Tracy's eriastrum *Eriastrum tracyi*	CR, CNPS 1B	Chaparral, cismontane woodland. Gravelly shale or clay; often in open areas. 315-760 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Ben Lomond buckwheat (= naked buckwheat) *Eriogonum nudum* var. *decurrens*	CNPS 1B	Chaparral, cismontane woodland, lower montane coniferous forest. Known only from Contra Costa and Santa Cruz Counties. Ponderosa pine sandhills in Santa Cruz County. 50-800 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Temblor buckwheat *Eriogonum temblorense*	CNPS 1B	Valley and foothill grassland. Barren clay or sandstone substrates. 300-1,000 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
San Mateo woolly sunflower *Eriophyllum latilobum*	FE, CT, CNPS 1B	Cismontane woodland. Endemic to San Mateo County. Often on roadcuts; found on and off of serpentine. 45-150 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
round-leaved filaree *Erodium macrophyllum*	CNPS 2	Cismontane woodland, valley and foothill grassland. Clay soils. 15-1,200 meters.	No habitat in project area.
Hoover's button-celery *Eryngium aristulatum* var. *hooveri*	CNPS 1B	Vernal pools. San Benito, Santa Clara, and San Luis Obispo Counties. Mostly historical. Alkaline depressions, vernal pools, roadside ditches and other wet places near the coast. 5-45 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Delta button-celery *Eryngium racemosum*	CE, CNPS 1B	Riparian scrub. Extant in Calaveras and Merced Counties; historical from San Joaquin and Stanislaus Counties. Seasonally inundated floodplain on clay. 3-75 meters.	No habitat in project area. Limited habitat potentially present in intermittent streams to fields within boundaries of Alternative 2. No impacts expected.
Spiny-sepaled cyoute –thistle (=button-celery) *Eryngium spinosepalum*	CNPS 1B	Vernal pools, valley and foothill grassland. Some sites on clay soil of granitic origin; vernal pools, within grassland. 100-420 meters	No habitat in project area. Limited habitat potentially present in intermittent streams to fields within boundaries of Alternative 2. No impacts expected.
Santa Cruz wallflower *Erysimum teretifolium*	FE, CSC, CNPS 1B	Lower montane coniferous forest, chaparral. Endemic to pine parkland area in Santa Cruz County. Inland marine sands (Zayante coarse sand). 120-610 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
talus fritillary *Fritillaria falcata*	CNPS 1B	Chaparral, cismontane woodland, lower montane coniferous forest. On shale, granite, or serpentine talus. 300-1,525 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
fragrant fritillary (= prairie bells) *Fritillaria liliacea*	CNPS 1B	Coastal scrub, valley and foothill grassland, coastal prairie. Often on serpentine; various soils reported though usually clay, in grassland. 3-410 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Congdon's tarplant *Hemizonia parryi* ssp. *congdonii*	CNPS 1B	Valley and foothill grassland. Alkaline soils, sometimes described as heavy white clay. 1-230 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Marin western flax *Hesperolinon congestum*	FE, CE, CNPS 1B	Chaparral, valley and foothill grassland. Known only from Marin, San Francisco, and San Mateo Counties. In serpentine barrens and in serpentine grassland and chaparral. 30-365 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Napa western flax *Hesperolinon serpentinum*	CNPS 1B	Chaparral. Mostly found in serpentine chaparral. 225-850 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Loma Prieta hoita *Hoita strobilina*	CNPS 1B	Chaparral, cismontane woodland, riparian woodland. Serpentine; mesic sites.	Occurs in vicinity of potential water recipient use. No potential effect.
Santa Cruz tarplant *Holocarpha macradenia*	FE, CSC, CNPS 1B	Coastal prairie, valley and foothill grassland. Light, sandy soil or sandy clay; often with non-natives. 10-260 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Contra Costa goldfields *Lasthenia conjugens*	FE, CSC, CNPS 1B	Valley and foothill grassland, vernal pools, cismontane woodland. Extirpated from most of its range; extremely endangered. Vernal pools, swales, low depressions, in open grassy areas. 1-445 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
perennial goldfields *Lasthenia macrantha* ssp. *macrantha*	CNPS 1B	Coastal bluff scrub, coastal dunes, coastal scrub. 5-520 meters	No habitat in project area.
pale-yellow layia *Layia heterotricha*	CNPS 1B	Pinyon-juniper woodland, valley and foothill grassland. Many historical, extirpated occurrences. Alkaline or clay soils; open areas. 270-1,365 (2,675)m.	Occurs in vicinity of potential water recipient use. No potential effect.
Munz's tidy-tips *Layia munzii*	CNPS 1B	Chenopod scrub, valley and foothill grassland. Hillsides, in white-gray alkaline clay soils, with grasses and chenopod scrub associates. 45-760 meters.	No habitat in project area.
legenere *Legenere limosa*	CNPS 1B	Vernal pools. Many historical occurrences are extirpated. In beds of vernal pools. 1-880 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Panoche pepper-grass *Lepidium jaredii* ssp. *album*	CNPS 1B	Valley and foothill grassland. Alkali bottoms, slopes, washes, alluvial fans; clay and gypsum-rich soils. 65-910 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
smooth lessingia *Lessingia micradenia* var. *glabrata*	CNPS 1B	Chaparral. Endemic to Santa Clara County. Serpentine; often on roadsides. 120-485 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Mt. Hamilton lomatium *Lomatium observatorium*	CNPS 1B	Cismontane woodland. Endemic to the Mount Hamilton Range; mostly around Mt. Hamilton itself. Open to partially shaded openings in *Pinus coulteri* -oak woodland. Sedimentary Franciscan rocks and volcanics. 1,219-1,330 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
red-flowered lotus *Lotus rubriflorus*	CNPS 1B	Valley and foothill grassland, cismontane woodland. Most recent sighting from sterile, red soils-volcanic mudflow deposits. 200-425 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
showy (=golden) madia *Madia radiata*	CNPS 1B	Valley and foothill grassland, cismontane woodland, chenopod scrub. Mostly on adobe clay in grassland or among shrubs. 25-1,125 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
arcuate bush mallow *Malacothamnus arcutatus (=M. fasciculat)*	CNPS 1B	Chaparral. Gravelly alluvium. 80-355 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Davidson's bush mallow *Malacothamnus davidsonii*	CNPS 1B	Coastal scrub, riparian woodland, chaparral. Sandy washes. 180-855 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Hall's bush mallow *Malacothamnus hallii (=M. fasciculatus*)	CNPS 1B	Chaparral. Some populations on serpentine. 10-550 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Oregon meconella (=white fairypoppy) *Meconella oregana*	CNPS 1B	Coastal prairie, coastal scrub. Open, moist places. 250-500 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
robust monardella (=robust coyote mint) *Monardella villosa* ssp *globosa*	CNPS 1B	Broadleaved upland forest, chaparral, cismontane woodland, valley and foothill grassland. Openings. 30-300 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
San Joaquin woollythreads *Monolopia congdonii*	FE, CE, CNPS 1B	Chenopod scrub and valley and foothill grassland. Endemic to San Joaquin Valley. Alkaline or loamy plains; sandy soils, often with grasses and within chenopod scrub. 60-800 meters.	Occurs in vicinity of potential water recipient use (SLU). Addressed in Biological Opinion for CVP/SWP
little mousetail *Myosurus minimus* ssp. *apus*	CNPS 1B	Vernal pools; alkaline soils. 20-640 meters	No habitat in project area.
shining navarretia *Navarretia nigelliformis* ssp. *radians*	CNPS 1B	Cismontane woodland, valley and foothill grassland, vernal pools. Apparently in grassland, and not necessarily in vernal pools. 200-1,000 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
prostrate navarretia *Navarretia prostrata*	CNPS 1B	Coastal scrub, valley and foothill grassland, vernal pools. Alkaline soils in grassland, or in vernal pools. 15-700 meters.	No habitat in project area.
Dudley's lousewort *Pedicularis dudleyi*	CR, CNPS 1B	Chaparral, north coast coniferous forest, valley and foothill grassland. Deep shady woods of older coast redwood forests; also in maritime chaparral. 100-490 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
white-rayed pentachaeta *Pentachaeta bellidiflora*	FE, CE, CNPS 1B	Valley and foothill grassland. Open dry rocky slopes and grassy areas, often on soils derived from serpentine bedrock. 35-620 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
slender pentachaeta *Pentachaeta exilis* ssp. *aeolica*	CNPS 1B	Cismontane woodland, valley and foothill grassland. Grassy areas. 635-855 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Santa Cruz Mts. beardtongue *Penstemon rattanii* var *kleei*	CNPS 1B	Chaparral, lower montane coniferous forest. Known only from Santa Clara and Santa Cruz Counties. Sandy shale slopes; sometimes in the transition between forest and chaparral. 400-1,100 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Gairdner's yampah *Perideridia gairdneri* ssp. *gairdneri*	CNPS 4	Broadleafed upland forest, chaparral, coastal prairie, valley and foothill grassland, vernal pools. Adobe flats or grasslands, wet meadows and vernal pools, under Pinus radiata along the coast; mesic sites. 0-350 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Mt. Diablo phacelia *Phacelia phacelioides*	CNPS 1B	Chaparral, cismontane woodland. Adjacent to trails, on rock outcrops and talus slopes; sometimes on serpentine. 500-1,370 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
San Francisco popcorn-flower *Plagiobothrys diffusus*	CE, CNPS 1B	Valley and foothill grassland, coastal prairie. Historically from grassy slopes with marine influence. 60-485 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
hairless popcorn-flower *Plagiobothrys glaber*	CNPS 1A	Meadows and seeps, marshes and swamps. Coastal salt marshes and alkaline meadows. 5-180 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Salinas Valley (=hooked) popcornflower *Plagiobothrys uncinatus*	CNPS 1B	Chaparral, cismontane woodland, valley and foothill grassland, coastal bluff scrub. Sandstone outcrops and canyon sides; often in burned or disturbed areas. 300-820 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Scotts Valley polygonum *Polygonum hickmanii*	FE, CSC, CNPS 1B	Valley and foothill grassland. Purisima sandstone or mudstone with a thin soil layer, vernally moist due to runoff. 210-250 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
slender-leaved pondweed *Potamogeton filiformis*	CNPS 2	Marshes and swamps. Shallow, clear water of lakes and drainage channels. 15-2,310 meters.	No habitat in project area.
Sanford's arrowhead *Sagittaria sanfordii*	CNPS 1B	Marshes and swamps. In standing or slow-moving freshwater ponds, marshes, and ditches. 0-610 meters.	Limited habitat in canals within project and alternative areas. No impacts expected.
rock sanicle *Sanicula saxatilis*	CR, CNPS 1B	Broadleafed upland forest, chaparral, valley and foothill grassland. Known only from Contra Costa and Santa Clara County bedrock outcrops and talus slopes in chaparral or oak woodland habitat. 615-1,215 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
rayless ragwort *Senecio aphanactis*	CNPS 2	Cismontane woodland, coastal scrub. Drying alkaline flats. 20-575 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Metcalf Canyon jewel-flower *Streptanthus albidus* ssp. *albidus*	FE, CSC, CNPS 1B	Valley and foothill grassland. Endemic to Santa Clara County. Relatively open areas in dry grassy meadows on serpentine soils; also on serpentine balds. 45-245 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
most beautiful (uncommon) jewelflower *Streptanthus albidus* ssp. *peramoenus*	CNPS 1B	Chaparral, valley and foothill grassland, cismontane woodland. Serpentine outcrops, on ridges and slopes. 120-730 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Mt. Hamilton jewelflower *Streptanthus callistus*	CNPS 1B	Chaparral, cismontane woodland, and serpentine soils.	Occurs in vicinity of potential water recipient use. No potential effect.
Arburua Ranch jewelflower *Streptanthus insignis* ssp. *lyonii*	CNPS 1B	Coastal scrub. Endemic to Merced County. Serpentine slopes, also on non-serpentine. 230-850 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
California seablite *Suaeda californica*	FE, CSC, CNPS 1B	Marshes and swamps. Margins of coastal salt marshes. 0-5 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Wright's trichocoronis *Trichocoronis wrightii* var. *wrightii*	CNPS 2	Marshes and swamps, riparian forest, meadows and seeps, vernal pools. Mud flats of vernal lakes, drying river beds, alkali meadows. 5-435 meters.	No habitat in project area.
showy Indian clover *Trifolium amoenum*	FE, CNPS 1B	Valley and foothill grassland, coastal bluff scrub. Sometimes on serpentine soil, open sunny sites, swales. Most recently sited on roadside and eroding cliff face. 5-560 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
Santa Cruz clover *Trifolium buckwestiorum*	CNPS 1B	Coastal prairie, broadleafed upland forest, cismontane woodland. Moist grassland. 60-545 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
water sack (=saline) clover *Trifolim depauperatum* var. *hydrophilum*	CNPS 1B	Marshes and swamps, valley and foothill grassland, vernal pools. Mesic, alkaline sites. 0-300 meters.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
PLANTS (continued)			
Santa Cruz clover *Trifolium buckwestiorum*	CNPS 1B	Coastal prairie, broadleafed upland forest, cismontane woodland. Endemic to Santa Cruz County. Moist grassland. 60-545 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
caper-fruited tropidocarpum *Tropidocarpum capparideum*	CNPS 1B	Valley and foothill grassland. Alkaline clay. 0-455 meters.	Occurs in vicinity of potential water recipient use. No potential effect.
INVERTEBRATES			
Opler's longhorn moth *Adela oplerella*	SA	From Marin County and the Oakland area on the inner Coast ranges south to Santa Clara County. One record from Santa Cruz County. All but Santa Cruz site is on serpentine grassland. Larvae feed on *Platystemon californicus*.	Occurs in vicinity of potential water recipient use. No potential effect.
Ciervo aegilian scarab beetle *Aegialia concinna*	SA	Known only from Fresno County in sandy substrates.	Occurs in vicinity of potential water recipient use. No potential effect.
Conservancy fairy shrimp *Branchinecta conservatio*	FE, CE	Endemic to the grasslands of the northern two-thirds of the Central Valley; found in large, turbid pools. Inhabit astatic pools located in swales formed by old, braided alluvium; filled by winter/spring rains, last until June.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP
longhorn fairy shrimp *Branchinecta longiantenna*	FE, CSC	Endemic to the eastern margin of the Central Coast Mountains in seasonally astatic grassland vernal pools. Inhabit small, clear-water depressions in sandstone and clear-to-turbid clay/grass-bottomed pools in shallow swales.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP
vernal pool fairy shrimp *Branchinecta lynchi*	FE, CSC	Endemic to the grasslands of the Central Valley, Central Coast Mountains, and South Coast Mountains, in astatic rain-filled pools. Inhabit small, clear-water sandstone-depression pools and grassed swale, earth slump, or basalt-flow depression pools.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
INVERTEBRATES (continued)			
isopod *Calasellus californicus*	SA	Known from Lake, Napa, and Santa Clara Counties.	Occurs in vicinity of potential water recipient use. No potential effect.
cuckoo wasp *Ceratochrysis menkei*	SA	No habitat information.	Occurs in vicinity of potential water recipient use. No potential effect.
Ohlone tiger beetle *Cicindela ohlone*	FE, CSC	Remnant native grasslands with California oatgrass and purple needlegrass in Santa Cruz County. Substrate is poorly-drained clay or sandy clay soil over bedrock of Santa Cruz mudstone.	Occurs in vicinity of potential water recipient use. No potential effect.
San Joaquin dune beetle *Coelus gracilis*	SA	Inhabits fossil dunes along the western edge of San Joaquin Valley; extirpated from Antioch Dunes (type locality). Inhabits sites containing sandy substrates.	Occurs in vicinity of potential water recipient use. No potential effect.
valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	Occurs only in the Central Valley of California, in association with blue elderberry (*Sambucus mexicana*). Prefers to lay eggs in elderberrries 2-8 inches in diameter; some preference shown for "stressed" elderberries.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
redheaded sphecid wasp *Eucerceris ruficeps*	SA	Central California interior dunes. Nests in hard-packed sand utilizing abandoned halictine bee burrows.	Occurs in vicinity of potential water recipient use. No potential effect.
Bay checkerspot butterfly *Euphydryas editha bayensis*	FE, CSC	Restricted to native grasslands on outcrops of serpentine soil in the vicinity of San Francisco Bay. *Plantago erecta* is the primary host plant; *Orthocarpus densiflorus* and *O. purpurscens* are the secondary host plants.	Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
San Bruno elfin butterfly *Incisalia mossii bayensis*	FE	Coastal, mountainous areas with grassy ground cover, mainly in the vicinity of San Bruno mountain, San Mateo County. Colonies are located on steep, north-facing slopes within the fog belt. Larval host plant is *Sedum spathulifolium*.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
INVERTEBRATES (continued)			
vernal pool tadpole shrimp *Lepidurus packardi*	FE, CE	Inhabits vernal pools and swales in the Sacramento Valley containing clear to highly turbid water. Pools commonly found in grass bottomed swales of unplowed grasslands. Some pools are mud-bottomed and highly turbid.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP
California linderiella *Linderiella occidentalis*	SA	Seasonal pools in unplowed grasslands with old alluvial soils underlain by hardpan or in sandstone depressions. Water in the pools has very low alkalinity, conductivity, and TDS.	Occurs in vicinity of potential water recipient use. No potential effect.
Hopping's blister beetle *Lytta hoppingi*	SA	Inhabits the foothills at the southern end of the Central Valley.	Occurs in vicinity of potential water recipient use. No potential effect.
molestan blister beetle *Lytta molesta*	SA	Inhabits the central valley of California, from Contra Costa to Kern and Tulare Counties.	Occurs in vicinity of potential water recipient use. No potential effect.
Morrison's blister beetle *Lytta morrisoni*	SA	Inhabitant of the southern Central Valley of California.	Occurs in vicinity of potential water recipient use. No potential effect.
Hom's micro-blind harvestman *Microcina homi*	SA	Known only from Santa Clara County in xeric habitats. Known only from serpentine rocks in grassland habitats.	Occurs in vicinity of potential water recipient use. No potential effect.
Jung's micro-blind harvestman *Microcina jungi*	SA	Grasslands in xeric habitats. Known only from type locality, junction of Silver Creek and San Felipe Roads, Santa Clara County. Found beneath serpentine rocks	Occurs in vicinity of potential water recipient use. No potential effect
Pinnacles optioservus riffle beetle *Optioservus canus*	SA	Aquatic. Found on rocks and in gravel of riffles in cool, swift, clear streams.	Occurs in vicinity of potential water recipient use. No potential effect
unsilvered fritillary *Speyeria adiaste adiaste*	SA	No habitat information	Occurs in vicinity of potential water recipient use. No potential effect

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
INVERTEBRATES (continued)			
Zayante band-winged grasshopper *Trimerotropis infantilis*	FE, CSC	Endemic to isolated sandstone deposits in the Santa Cruz Mountains. Restricted to sand parkland habitat found on ridges and hills within the Zayante sand hills ecosystem.	Occurs in vicinity of potential water recipient use. No potential effect.
mimic tryonia (=California brackishwater snail) *Tryonia imitator*	SA	Inhabits coastal lagoons, estuaries and salt marshes, from Sonoma County south to San Diego County. Found only in permanently submerged areas in a variety of sediment types; able to withstand a wide range of salinities.	Occurs in vicinity of potential water recipient use. No potential effect.
FISH			
green sturgeon *Acipenser medirostris*	FT	Spawn in the Sacramento River and the Klamath River. Spawn at temps between 8-14 C. Preferred spawning substrate is large cobble, but can range from clean sand to bedrock.	No habitat in project area.
tidewater goby *Eucyclogobius newberryi*	FE, CSC	Brackish water habitats along the California coast from Agua Hedionda Lagoon, San Diego County To the mouth of the Smith River. Found in shallow lagoons and lower stream reaches, they need fairly still but not stagnant water and high oxygen levels.	Occurs in vicinity of potential water recipient use. No potential effect.
Delta smelt *Hypomesus transpacificus*	FT, CT	Sacramento-San Joaquin delta. Seasonally in Suisun Bay, Carquinez Strait and San Pablo Bay. Seldom found at salinities >10 ppt. Most often at salinities <2ppt.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
River lamprey *Lampetra ayresi*	CSC	Lower Sacramento River, San Joaquin River and Russian River. May occur in coastal streams north of San Francisco Bay. Adults need clean, gravelly riffles, ammocoetes need sandy backwaters or stream edges, good water quality and temps <25 c.	No habitat in project area.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
FISH (continued)			
Coho salmon - central California ESU *Oncorhynchus kisutch*	FE, CE	Federal listing = populations between Punta Gorda and San Lorenzo River. State listing = populations south of Punta Gorda. Require beds of loose, silt-free, coarse gravel for spawning. Also need cover, cool water and sufficient dissolved oxygen.	Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
Central Valley steelhead *Oncorhynchus mykiss*	FT, CSC	Populations in the Sacramento and San Joaquin Rivers and their tributaries. Cool, swift, shallow water and clean loose gravel for spawning, and suitably large pools in which to spend the summer.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP
steelhead - Central California Coast ESU *Oncorhynchus mykiss irideus*	FT	Federal listing = populations between Punta Gorda and San Lorenzo River. State listing = populations south of Punta Gorda. Require beds of loose, silt-free, coarse gravel for spawning. Also need cover, cool water and sufficient dissolved oxygen.	Occurs in vicinity of potential water recipient use. No potential effect
steelhead - South/Central California Coast ESU *Oncorhynchus mykiss irideus*	FT, CSC	Federal listing refers to runs in coastal basins from the Pajaro River south to, but not including, the Santa Maria River.	Occurs in vicinity of potential water recipient use. No potential effect
winter-run chinook salmon, Sacramento River *Oncorhynchus tshawytscha*	FT, CT	Adult numbers depend on pool depth and volume, amount of cover, and proximity to gravel. Water temperatures greater than 27°C lethal to adults federal listing refers to populations spawning in Sacramento River and tributaries.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP
Central Valley spring-run chinook salmon *Oncorhynchus tshawytscha*	FT, CT	Adult numbers depend on pool depth and volume, amount of cover, and proximity to gravel. Water temperatures greater than 27°C lethal to adults federal listing refers to populations spawning in Sacramento River and tributaries.	No habitat in project area. Addressed in Biological Opinion for CVP/SWP

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
FISH (continued)			
Central Valley fall/late fall-run chinook salmon *Oncorhynchus tshawytscha*	FC, CSC	Sacramento and San Joaquin River Basins and their tributaries, east of Carquinez Strait, California. Need cool, clean water, upland and riparian (stream bank) vegetation to stabilize soil and provide shade, clean gravel for spawning and egg-rearing, large woody debris to provide resting and hiding places.	No habitat in project area.
Sacramento splittail *Pogonichthys macrolepidotus*	CSC	Endemic to the lakes and rivers of the Central Valley, but now confined to the delta, Suisun Bay and associated marshes. Slow moving river sections, dead-end sloughs. Require flooded vegetation for spawning and foraging for young.	No habitat in project area.
longfin smelt *Spirinchus thaleichthys*	CSC	Euryhaline, nektonic and anadromous. Found in open waters of estuaries, mostly in middle or bottom of water column. Prefer salinities of 15-30 ppt, but can be found in completely freshwater to almost pure seawater.	No habitat in project area.
AMPHIBIANS			
California tiger salamander *Ambystoma californiense*	FE, CSC	Species now listed as threatened statewide. Populations in Santa Barbara and Sonoma Counties formerly listed as endangered need underground refuges, especially ground squirrel burrows and vernal pools or other seasonal water sources for breeding.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
California red-legged frog *Rana aurora draytonii*	FE, CSC	Lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development. Must have access to estivation habitat.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
foothill yellow-legged frog *Rana boylii*	CSC	Partly-shaded, shallow streams and riffles with a rocky substrate in a variety of habitats. Need at least some cobble-sized substrate for egg-laying. Need at least 15 weeks to attain metamorphosis.	No habitat in project area. Limited habitat in narrow riparian strips within boundaries of Alternative 2. No impacts expected.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
AMPHIBIANS (continued)			
western spadefoot *Spea (=Scaphiopus) hammondii*	CSC	Occurs primarily in grassland habitats, but can be found in valley-foothill hardwood woodlands. Vernal pools are essential for breeding and egg-laying.	No habitat in project area.
REPTILES			
silvery legless lizard *Anniella pulchra pulchra*	CSC	Sandy or loose loamy soils under sparse vegetation. Soil moisture is essential. They prefer soils with high moisture content.	Limited habitat in project area.
northwestern pond turtle *Clemmys marmorata marmorata*	CSC	Associated with permanent or nearly permanent water in a wide variety of habitats. Requires basking sites. Nests sites may be found up to 0.5 km from water.	No nesting habitat in project area. May occupy canals. No impacts expected.
southwestern pond turtle *Clemmys marmorata pallida*	CSC	Inhabits permanent or nearly permanent bodies of water in many habitat types; below 6000 ft elevation. Require basking sites such as partially submerged logs, vegetation mats, or open mud banks. Need suitable nesting sites.	No nesting habitat in project area. May occupy canals. No impacts expected.
western pond turtle *Emys* (=*Clemmys*) *marmorata*	CSC	A thoroughly aquatic turtle of ponds, marshes, rivers, streams and irrigation ditches with aquatic vegetation. Need basking sites and suitable (sandy banks or grassy open fields) upland habitat for egg-laying.	No nesting habitat in project area. May occupy canals. No impacts expected.
blunt-nosed leopard lizard *Gambelia* sila	FE, CE, CFP	Resident of sparsely vegetated alkali and desert scrub habitats, in areas of low topographic relief. Seeks cover in mammal burrows, under shrubs or structures such as fence posts; they do not excavate their own burrows.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
San Joaquin coachwhip (=whipsnake) *Masticophis flagellum ruddocki*	CSC	Open, dry habitats with little or no tree cover. Found in valley grassland and saltbush scrub in the San Joaquin Valley. Needs mammal burrows for refuge and oviposition sites.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
REPTILES (continued)			
Alameda whipsnake [=striped racer] *Masticophis lateralis euryxanthus*	FT, CT	Restricted to valley-foothill hardwood habitat of the coast ranges between vicinity of Monterey and n San Francisco Bay. Inhabits south-facing slopes and ravines where shrubs form a vegetative mosaic with oak trees and grasses.	Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
California horned lizard *Phrynosoma coronatum frontale*	CSC	Occurs in several habitat types, ranging from areas with an exposed Gravelly-sandy substrate containing scattered shrubs (e.g., California buckwheat), to clearings in riparian woodlands, to dry uniform chamise chaparralto annual grassland with scattered perennial seepweed or saltbush. Reaches it maximum abundance in sandy loam areas and on alkali flats, the latter often dominated by iodine bush (*Allenrolfea occidentalis*). This species can apparently survive in vineyards.	Occurs in vicinity of potential water recipient use. No potential effect.
giant garter snake *Thamnophis gigas*	FE, CE	Prefers freshwater marsh and low gradient streams. Has adapted to drainage canals and irrigation ditches. This is the most aquatic of the garter snakes in California.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	FE, CE, CFP	Vicinity of freshwater marshes, ponds and slow moving streams in San Mateo County and extreme northern Santa Cruz County prefers dense cover and water depths of at least one foot. Upland areas near water are also very important.	Occurs in vicinity of potential water recipient use. No potential effect.
BIRDS			
Cooper's hawk *Accipiter cooperii*	CSC	Woodland, chiefly of open, interrupted or marginal type. Nest sites mainly in riparian growths of deciduous trees, as in canyon bottoms on river flood-plains; also, live oaks.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
tricolored blackbird *Agelaius tricolor*	CSC	(Nesting colony) highly colonial species, most numerous in Central Valley and vicinity. Largely endemic to California. Requires open water, protected nesting substrate, and foraging area with insect prey within a few km of the colony.	No habitat in project area.
Bell's sage sparrow *Amphispiza belli belli*	CSC	(Nesting) nests in chaparral dominated by fairly dense stands of chamise. Found in coastal sage scrub in south of range. Nest located on the ground beneath a shrub or in a shrub 6-18 inches above ground. Territories about 50 yards apart.	Occurs in vicinity of potential water recipient use. No potential effect.
golden eagle *Aquila chrysaetos*	CSC, CFP	Rolling foothills, mountain areas, sage-juniper flats, and desert. Cliff-walled canyons provide nesting habitat in most parts of range; also, large trees in open areas.	Occurs in vicinity of potential water recipient use. No potential effect.
great blue heron *Ardea herodias*	SA	Colonial nester in tall trees, cliffsides, and sequestered spots on marshes. Rookery sites in close proximity to foraging areas: Marshes, lake margins, tide-flats, rivers and streams, wet meadows.	Occurs in vicinity of potential water recipient use. No potential effect.
short-eared owl *Asio flammeus*	CSC	Found in swamp lands, both fresh and salt; lowland meadows; irrigated alfalfa fields. Tule patches/tall grass needed for nesting/daytime seclusion. Nests on dry ground in depression concealed in vegetation.	Occurs in vicinity of potential water recipient use. No potential effect.
long-eared owl *Asio otus*	CSC	Riparian bottomlands grown to tall willows and cottonwoods; also, belts of live oak paralleling stream courses. Requires adjacent open land productive of mice and the presence of old nests of crows, hawks, or magpies for breeding.	Occurs in vicinity of potential water recipient use. No potential effect.
western burrowing owl *Athene cunicularia hypugaea*	CSC	(Burrow sites) Open, dry annual or perennial grasslands, deserts and scrublands characterized by low-growing vegetation.	No habitat in project area.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
marbled murrelet *Brachyramphus marmoratus*	FT, CE	(Nesting) feeds near-shore; nests inland along coast, from Eureka to Oregon border and from Half Moon Bay to Santa Cruz. Nests in old-growth redwood-dominated forests, up to six miles inland, often in Douglas firs.	Occurs in vicinity of potential water recipient use. No potential effect.
Aleutian Canada goose *Branta canadensis leucopareia*	FD, CE	(Wintering) winters on lakes and inland prairies. Forages on natural pasture or that cultivated to grain; loafs on lakes, reservoirs, ponds.	No habitat in project area.
ferruginous hawk *Buteo regalis*	CSC	(Wintering) open grasslands, sagebrush flats, desert scrub, low foothills and fringes of pinyon-juniper habitats. Mostly eats lagomorphs, ground squirrels, and mice. Population trends may follow lagomorph population cycles.	No habitat in project area.
Swainson's hawk *Buteo swainsoni*	CT	(Nesting) breeds in stands with few trees in juniper-sage flats, riparian areas and in oak savannah. Requires adjacent suitable foraging areas such as grasslands, or alfalfa or grain fields supporting rodent populations.	No habitat in project area. Limited habitat in narrow riparian strips within boundaries of Alternative 2. No impacts expected.
Vaux's swift *Chaetura vauxi*	CSC	(Nesting) redwood, Douglas fir, and other coniferous forests. Nests in large hollow trees and snags. Often nests in flocks. Forages over most terrain and habitats but shows a preference for foraging over rivers and lakes.	No habitat in project area. Limited habitat in narrow riparian strips within boundaries of Alternative 2. No impacts expected.
western snowy plover *Charadrius alexandrinus nivosus*	FE, CSC	(Nesting) federal listing applies only to the Pacific coastal population. Sandy beaches, salt pond levees and shores of large alkali lakes. Needs sandy, gravelly or friable soils for nesting.	Occurs in vicinity of potential water recipient use. No potential effect.
mountain plover *Charadrius montanus*	CSC	(Wintering) short grasslands, freshly plowed fields, newly sprouting grain fields, and sometimes sod farms short vegetation, bare ground and flat topography. Prefer grazed areas and areas with burrowing rodents.	No habitat in project area. Limited habitat in pastures within boundaries of Alternative 2. No impacts expected.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
northern harrier *Circus cyaneus*	CSC	(Nesting) coastal salt and fresh-water marsh. Nest and forage in grasslands, from salt grass in desert sink to mountain cienagas. Nests on ground in shrubby vegetation, usually at marsh edge; nest built of a large mound of sticks in wet areas.	Occurs in vicinity of potential water recipient use. No potential effect.
western yellow-billed cuckoo *Coccyzus americanus occidentalis*	CE	(Nesting) riparian forest nester, along the broad, lower flood-bottoms of larger river systems. Nests in riparian jungles of willow, often mixed with cottonwoods, w/ lower story of blackberry, nettles, or wild grape.	Potential habitat in project area. No impacts expected.
yellow rail *Coturnicops noveboracensis*	CSC	Summer resident in eastern Sierra Nevada in Mono County. Fresh-water marshlands.	Occurs in vicinity of potential water recipient use. No potential effect.
black swift *Cypseloides* niger	CSC	(Nesting) coastal belt of Santa Cruz and Monterey Co; central and southern Sierra Nevada; San Bernardino and San Jacinto Mountains. Breeds in small colonies on cliffs behind or adjacent to waterfalls in deep canyons and sea-bluffs above surf; forages widely.	Occurs in vicinity of potential water recipient use. No potential effect.
snowy egret *Egretta thula*	SA	Colonial nester, with nest sites situated in protected beds of dense tules. Rookery sites situated close to foraging areas: marshes, tidal-flats, streams, wet meadows, and borders of lakes.	Occurs in vicinity of potential water recipient use. No potential effect.
white-tailed (=black shouldered) kite *Elanus leucurus*	CFP	(Nesting) rolling foothills/valley margins with scattered oaks and river bottomlands or marshes next to deciduous woodland open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees for nesting and perching.	No habitat in project area. Limited habitat in narrow riparian strips and pastures within boundaries of Alternative 2. No impacts expected.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
little willow flycatcher *Empidonax traillii brewsteri*	CE	Rare to locally uncommon summer resident in wet meadows and montane riparian habitats from 600-2,440 m (2,000-8,000 feet) in elevation and a common spring (mid-May to early June) and fall (mid-August to early September) migrant at lower elevations, primarily in riparian habitats, throughout the state exclusive of the North Coast . Most of the remaining breeding populations occur in isolated mountain meadows of the Sierra Nevada and Cascades. Part of state-listed species.	No habitat in project area. May occur during migration in narrow riparian strips within boundaries of Alternative 2. No impacts expected.
California horned lark *Eremophila alpestris actia*	CSC	Coastal regions, chiefly from Sonoma Co. To San Diego Co. Also main part of San Joaquin Valley and east to foothills. Short-grass prairie, "bald" hills, mountain meadows, open coastal plains, fallow grain fields, alkali flats.	Limited habitat in Alternative 2 area. No impacts expected to occur.
merlin *Falco columbarius*	CSC	Seacoast, tidal estuaries, open woodlands, savannahs, edges of grasslands and deserts, farms and ranches. Clumps of trees or windbreaks are required for roosting in open country.	Occurs in vicinity of potential water recipient use. No potential effect.
prairie falcon *Falco mexicanus*	CSC	Inhabits dry, open terrain, either level or hilly. Breeding Sites located on cliffs. Forages far afield, even to marshlands and ocean shores.	Occurs in vicinity of potential water recipient use. No potential effect.
American peregrine falcon *Falco peregrinus anatum*	FD, CE, CFP	(Nesting) near wetlands, lakes, rivers, or other water; on cliffs, banks, dunes, mounds; also, human-made structures. Nest consists of a scrape on a depression or ledge in an open site.	No habitat in project area.
saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	CSC	Resident of the San Francisco Bay region, in fresh and salt water marshes. Requires thick, continuous cover down to water surface for foraging; tall grasses, tule patches, willows for nesting.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
greater sandhill crane *Grus canadensis tabida*	CT, CFP	(Nesting and wintering) nests in wetland habitats in northeastern California; winters in the Central Valley. Prefer grain fields with in 4 miles of a shallow body of water used as a communal roost site; irrigated pasture used as loaf sites	No habitat in project area. May occur during winter in pastures within boundaries of Alternative 2. No impacts expected.
California condor *Gymnogyps californianus*	FE, CE, CFP	Require vast expanses of open savannah, grasslands, and foothill chaparral in mountain ranges of moderate altitude. Deep canyons containing clefts in the rocky walls provide nesting sites. Forages up to 100 miles from roost/nest.	Occurs in vicinity of potential water recipient use (SLU). Addressed in Biological Opinion for CVP/SWP
bald eagle *Haliaeetus leucocephalus*	FT, CE, CFP	(Nesting and wintering) ocean shore, lake margins, and rivers for both nesting and wintering. Most nests within 1 mile of water. Nests in large, old-growth, or dominant live tree w/open branches, especially ponderosa pine. Roosts communally in winter.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
loggerhead shrike *Lanius ludovicianus*	CSC	(Nesting) broken woodlands, savannah, pinyon-juniper, Joshua tree, and riparian woodlands, desert oases, scrub and washes. Prefers open country for hunting, with perches for scanning, and fairly dense shrubs and brush for nesting.	No habitat in project area. Limited habitat in narrow riparian strips and pastures within boundaries of Alternative 2. No impacts expected.
California black rail *Laterallus jamaicensis coturniculus*	CT, CFP	Mainly inhabits salt-marshes bordering larger bays. Occurs in tidal salt marsh heavily grown to pickleweed; also in fresh-water and brackish marshes, all at low elevation.	Occurs in vicinity of potential water recipient use. No potential effect.
Alameda song sparrow *Melospiza melodia pusillula*	CSC	Resident of salt marshes bordering south arm of San Francisco Bay. Inhabits *Salicornia* marshes; nests low in *Grindelia* bushes (high enough to escape high tides) and in *Salicornia*.	Occurs in vicinity of potential water recipient use. No potential effect.
black-crowned night heron *Nycticorax nycticorax*	SA	Colonial nester, usually in trees, occasionally in tule patches. Rookery sites located adjacent to foraging areas: lake margins, mud-bordered bays, marshy spots.	Occurs in vicinity of potential water recipient use. No potential effect.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
long-billed curlew *Numenius americanus*	CSC	(Nesting) breeds in upland shortgrass prairies and wet meadows in northeastern California. Habitats on gravelly soils and gently rolling terrain are favored over others.	No habitat in project area. Limited habitat for non-breeding birds in pastures within boundaries of Alternative 2. No impacts expected.
osprey *Pandion haliaetus*	CSC	Ocean shore, bays, fresh-water lakes, and larger streams. Large nests built in tree-tops within 15 miles of a good fish-producing body of water.	Occurs in vicinity of potential water recipient use. No potential effect.
white-faced ibis *Plegadis chihi*	CSC	(Rookery site) shallow fresh-water marsh. Dense tule thickets for nesting interspersed with areas of shallow water for foraging.	No habitat in project area.
California clapper rail *Rallus longirostris obsoletus*	FE, CE, CFP	Salt-water and brackish marshes traversed by tidal sloughs in the vicinity of San Francisco Bay. Associated with abundant growths of pickleweed, but feeds away from cover on invertebrates from mud-bottomed sloughs.	Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
bank swallow *Riparia riparia*	CT	(Nesting) colonial nester; nests primarily in riparian and other lowland habitats west of the desert. Requires vertical banks/cliffs with fine-textured/sandy soils near streams, rivers, lakes, and the ocean to dig nesting hole.	Occurs in vicinity of potential water recipient use. No potential effect.
black skimmer *Rynchops niger*	CSC	(Nesting colony) nests along the north and south ends of the Salton Sea; also on salt pond dikes of south San Diego Bay. Nests on gravel bars, low islets, and sandy beaches, in unvegetated sites. Nesting colonies usually less than 200 pairs.	Occurs in vicinity of potential water recipient use. No potential effect.
California least tern *Sterna antillarum browni*	FE, CSC, CFP	(Nesting colony) nests along the coast from San Francisco Bay south to northern Baja California. Colonial breeder on bare or sparsely vegetated, flat substrates: sand beaches, alkali flats, land fills, or paved areas.	Occurs in vicinity of potential water recipient use. No potential effect

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
BIRDS (continued)			
Le Conte's thrasher *Toxostoma lecontei*	CSC	Desert resident; primarily of open desert wash, desert scrub, alkali desert scrub, and desert succulent scrub habitats. Commonly nests in a dense, spiny shrub or densely branched cactus in desert wash habitat, usually 2-8 feet above ground.	Occurs in vicinity of potential water recipient use. No potential effect.
Least Bell's vireo *Vireo bellii pusillus*	FE, CE	(Nesting) summer resident of southern California in low riparian in vicinity of water or in dry river bottoms; below 2,000 ft. Nests placed along margins of bushes or on twigs projecting into pathways, usually willow, baccharis, mesquite.	Limited potential habitat in vicinity of Alternative 2 will not affected by project.
yellow-headed blackbird *Xanthocephalus xanthocephalus*	SA	Nests in freshwater emergent wetlands with dense vegetation and deep water. Often along borders of lakes or ponds. Nests only where large insects such as Odonata are abundant, nesting timed with maximum emergence of aquatic insects.	Occurs in vicinity of potential water recipient use. No potential effect.
MAMMALS			
San Joaquin antelope squirrel *Ammospermophilus nelsoni*	CT	Western San Joaquin Valley from 200-1,200 ft elevation On dry, sparsely vegetated loam soils. Dig burrows or use kangaroo rat burrows. Need widely scattered shrubs, forbs nd grasses in broken terrain with gullies and washes	No habitat in project area.
pallid bat *Antrozous pallidus*	CSC	Deserts, grasslands, shrublands, woodlands and forests. Most common in open, dry habitats with rocky areas for roosting. Roosts must protect bats from high temperatures. Very sensitive to disturbance of roosting sites.	Occurs in vicinity of potential water recipient use. No potential effect.
Pacific western big-eared bat *Corynorhinus* (=*Plecotus*) *townsendii townsendii*	CSC	Maternity and hibernation colonies can be found in caves and mine tunnels, relatively cold places for hibernation. Can be found in conifer, hardwood mixed forests and woodlands, grasslands, savanna, chaparral and riparian areas. Feeds on flying insects near the foliage of shrubs and trees.	No habitat in project area. Foraging and roosting habitat present in the riparian areas within the boundaries of Alternative 2. No impacts expected.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
MAMMALS (continued)			
Berkeley kangaroo rat *Dipodomys heermanni berkeleyensis*	SA	Open grassy hilltops and open spaces in chaparral and blue oak/digger pine woodlands. Needs fine, deep, well-drained soil for burrowing.	Occurs in vicinity of potential water recipient use. No potential effect.
giant kangaroo rat *Dipodomys ingens*	FE, CE	Annual grasslands on the western side of the San Joaquin Valley, marginal habitat in alkali scrub. Need level terrain and sandy loam soils for burrowing.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
short-nosed kangaroo rat *Dipodomys nitratoides brevinasus*	CSC	Western side of San Joaquin Valley in grassland and desert shrub associations, especially *Atriplex*. Occurs in highly alkaline soils around Soda Lake. Needs friable soils. Favors flat to gently sloping terrain.	No habitat in project area.
Fresno kangaroo rat *Dipodomys nitratoides exilis*	FE, CSC	Alkali sink-open grassland habitats in western Fresno County. Bare alkaline clay-based soils subject to seasonal inundation, with more friable soil mounds around shrubs and grasses.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP
Tipton kangaroo rat *Dipodomys nitratoides nitratoides*	FE, CT	Saltbrush scrub and sink scrub communities in the Tulare Lake basin of the southern San Joaquin Valley. Needs soft friable soils which escape seasonal flooding. Digs burrows in elevated soil mounds at bases of shrubs.	Occurs in vicinity of potential water recipient use (SLU). To be addressed in Biological Opinion for San Luis Unit long-term water service contract renewal.
Santa Cruz kangaroo rat *Dipodomys venustus venustus*	SA	Silverleaf manzanita mixed chaparral in the Zayante Sand Hills ecosystem of the Santa Cruz Mountains. Needs soft, well-drained sand.	Occurs in vicinity of potential water recipient use. No potential effect.
greater western mastiff-bat *Eumops perotis californicus*	CSC	Many open, semi-arid to arid habitats, including conifer and deciduous woodlands, coastal scrub, grasslands, chaparral etc roosts in crevices in cliff faces, high buildings, trees and tunnels.	No habitat in project area. Foraging and roosting habitat present in the riparian areas within the boundaries of Alternative 2. No impacts expected.

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
MAMMALS (continued)			
hoary bat *Lasiurus cinereus*	CSC	Prefers open habitats or habitat mosaics, with access to trees for cover and open areas or habitat edges for feeding. Roosts in dense foliage of medium to large trees. Feeds primarily on moths. Requires water.	Occurs in vicinity of potential water recipient use. No potential effect
Yuma myotis *Myotis yumanensis*	SA	Optimal habitats are open forests and woodlands with sources of water over which to feed. Distribution is closely tied to bodies of water. Maternity colonies in caves, mines, buildings or crevices.	Occurs in vicinity of potential water recipient use. No potential effect
San Francisco dusky-footed woodrat *Neotoma fuscipes annectens*	CSC	Forest habitats of moderate canopy and moderate to dense understory. Also in chaparral habitats. Constructs nests of shredded grass, leaves and other material. May be limited by availability of nest-building materials.	Occurs in vicinity of potential water recipient use. No potential effect
Southern grasshopper mouse *Onychomys torridus ramona*	CSC	Desert areas, especially scrub habitats with friable soils for digging. Prefers low to moderate shrub cover. Feeds almost exclusively on arthropods, especially scorpions and orthopteran insects.	Occurs in vicinity of potential water recipient use. No potential effect
Tulare grasshopper mouse *Onychomys torridus tularensis*	CSC	Hot, arid valleys and scrub deserts in the southern San Joaquin Valley. Diet almost exclusively composed of arthropods, therefore needs abundant supply of insects.	Occurs in vicinity of potential water recipient use. No potential effect
San Joaquin pocket mouse *Perognathus inornatus inornatus*	SA	Typically found in grasslands and blue oak savannas. Needs friable soils.	Occurs in vicinity of potential water recipient use. No potential effect
salt-marsh harvest mouse *Reithrodontomys raviventris*	FE, CE, CFP	Only in the saline emergent wetlands of San Francisco Bay and its tributaries. Pickleweed is primary habitat. Do not burrow, build loosely organized nests. Require higher areas for flood escape.	Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP

Table C-1. Special Status Species Potentially Occurring in the Vicinity of the Project Site or of Water Transfer Recipients

NAME	STATUS	HABITAT	POTENTIAL FOR EFFECT
MAMMALS (continued)			
salt marsh vagrant shrew *Sorex vagrans halicoetes*	CSC	Salt marshes of the south arm of San Francisco Bay. Medium high marsh 6-8 ft above sea level where abundant driftwood is scattered among Salicornia.	Occurs in vicinity of potential water recipient use. No potential effect
American badger *Taxidea taxus*	CSC	Most abundant in drier open stages of most shrub, forest, and herbaceous habitats, with friable soils. Need sufficient food, friable soils and open, uncultivated ground. Prey on burrowing rodents. Dig burrows.	No habitat in project area.
San Joaquin kit fox *Vulpes macrotis* mutica	FE, CSC	Annual grasslands or grassy open stages with scattered shrubby vegetation. Need loose-textured sandy soils for burrowing, and suitable prey base.	No habitat in project area. Occurs in vicinity of potential water recipient use. Addressed in Biological Opinion for CVP/SWP

Source: Status codes derived from CNDDB (CDFG 2006a), CDFG (2006b). Habitat information from CNDDB (CDFG 2006a) and CWHR (CDFG 2000)

Codes:

FE = federally listed as endangered
FT = federally listed as threatened
FPT = proposed for federal listing as threatened
FC = candidate for federal listing
CE = listed by California as endangered
CT = listed by California as threatened
CR = listed by California as rare
CFP = California Fully Protected species
CSC = California species of concern
SA = Special Animal – tracked in the CNDDB
CNPS = California Native Plant Society
1A = presumed extinct in California
1B = rare, threatened or endangered in California and elsewhere
2 = rare in California but more common elsewhere
4 = plants of limited distribution; a watch list.

Attachment C-2

USFWS Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

June 19, 2007

Document Number: 070619032337

Lance Mobley
Entrix
590 Ygnacio Valley Road
Suite 200
Walnut Creek, CA 94596

Subject: Species List for Exchange Contractors

Dear: Lance Mobley

We are sending this official species list in response to your June 19, 2007 request for information about endangered and threatened species. The list covers the California counties and/or U.S. Geological Survey 7½ minute quad or quads you requested.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

Please read Important Information About Your Species List (below). It explains how we made the list and describes your responsibilities under the Endangered Species Act.

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be September 17, 2007.

Please contact us if your project may affect endangered or threatened species or if you have any questions about the attached list or your responsibilities under the Endangered Species Act. A list of Endangered Species Program contacts can be found at www.fws.gov/sacramento/es/branches.htm.

Endangered Species Division

Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 070619032337

Database Last Updated: March 5, 2007

Quad Lists

Listed Species

Invertebrates

- Branchinecta conservatio
  - Conservancy fairy shrimp (E)
  - Critical habitat, Conservancy fairy shrimp (X)
- Branchinecta longiantenna
  - Critical habitat, longhorn fairy shrimp (X)
  - longhorn fairy shrimp (E)
- Branchinecta lynchi
  - Critical habitat, vernal pool fairy shrimp (X)
  - vernal pool fairy shrimp (T)
- Desmocerus californicus dimorphus
  - valley elderberry longhorn beetle (T)
- Euphydryas editha bayensis
  - bay checkerspot butterfly (T)
  - Critical habitat, bay checkerspot butterfly (X)
- Incisalia mossii bayensis
  - San Bruno elfin butterfly (E)
- Lepidurus packardi
  - Critical habitat, vernal pool tadpole shrimp (X)
  - vernal pool tadpole shrimp (E)

Fish

- Acipenser medirostris
    - green sturgeon (T) (NMFS)

- Eucyclogobius newberryi
    - tidewater goby (E)

- Hypomesus transpacificus
    - delta smelt (T)

- Oncorhynchus kisutch
    - coho salmon - central CA coast (E) (NMFS)
    - Critical habitat, coho salmon - central CA coast (X) (NMFS)

- Oncorhynchus mykiss
    - Central California Coastal steelhead (T) (NMFS)
    - Central Valley steelhead (T) (NMFS)
    - Critical habitat, Central California coastal steelhead (X) (NMFS)
    - Critical habitat, Central Valley steelhead (X) (NMFS)
    - South Central California steelhead (T) (NMFS)

- Oncorhynchus tshawytscha
    - Central Valley spring-run chinook salmon (T) (NMFS)
    - winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

- Ambystoma californiense
    - California tiger salamander, central population (T)
    - Critical habitat, CA tiger salamander, central population (X)

- Rana aurora draytonii
    - California red-legged frog (T)
    - Critical habitat, California red-legged frog (X)

Reptiles

- Gambelia (=Crotaphytus) sila
    - blunt-nosed leopard lizard (E)

- Masticophis lateralis euryxanthus
    - Alameda whipsnake [=striped racer] (T)
    - Critical habitat, Alameda whipsnake (X)

- Thamnophis gigas
    - giant garter snake (T)

- Thamnophis sirtalis tetrataenia
    - San Francisco garter snake (E)

Birds

- Brachyramphus marmoratus
    - Critical habitat, marbled murrelet (X)

  - marbled murrelet (T)

- Charadrius alexandrinus nivosus
  - western snowy plover (T)

- Gymnogyps californianus
  - California condor (E)

- Haliaeetus leucocephalus
  - bald eagle (T)

- Rallus longirostris obsoletus
  - California clapper rail (E)

- Sternula antillarum (=Sterna, =albifrons) browni
  - California least tern (E)

- Vireo bellii pusillus
  - Least Bell's vireo (E)

Mammals

- Dipodomys ingens
  - giant kangaroo rat (E)

- Dipodomys nitratoides exilis
  - Critical habitat, Fresno kangaroo rat (X)
  - Fresno kangaroo rat (E)

- Dipodomys nitratoides nitratoides
  - Tipton kangaroo rat (E)

- Reithrodontomys raviventris
  - salt marsh harvest mouse (E)

- Vulpes macrotis mutica
  - San Joaquin kit fox (E)

Plants

- Castilleja affinis ssp. neglecta
  - Tiburon paintbrush (E)

- Ceanothus ferrisae
  - Coyote ceanothus (E)

- Chamaesyce hooveri
  - Critical habitat, Hoover's spurge (X)

- Cordylanthus palmatus
  - palmate-bracted bird's-beak (E)

- Dudleya setchellii
    - Santa Clara Valley dudleya (E)

- Eriophyllum latilobum
    - San Mateo woolly sunflower (E)

- Holocarpha macradenia
    - Critical habitat, Santa Cruz tarplant (X)
    - Santa Cruz tarplant (T)

- Lasthenia conjugens
    - Contra Costa goldfields (E)
    - Critical habitat, Contra Costa goldfields (X)

- Monolopia congdonii (=Lembertia congdonii)
    - San Joaquin woolly-threads (E)

- Streptanthus albidus ssp. albidus
    - Metcalf Canyon jewelflower (E)

- Suaeda californica
    - California sea blite (E)

Candidate Species

Fish

- Oncorhynchus tshawytscha
    - Central Valley fall/late fall-run chinook salmon (C) (NMFS)
    - Critical habitat, Central Valley fall/late fall-run chinook (C) (NMFS)

Birds

- Coccyzus americanus occidentalis
    - Western yellow-billed cuckoo (C)

Quads Containing Listed, Proposed or Candidate Species:

STRATFORD (313A)

WESTHAVEN (313B)

KETTLEMAN CITY (313C)

HURON (314A)

GUIJARRAL HILLS (314B)

AVENAL (314C)

LA CIMA (314D)

COALINGA (315A)

BURREL (336B)

VANGUARD (336C)

LEMOORE (336D)

FIVE POINTS (337A)

WESTSIDE (337B)

HARRIS RANCH (337C)

CALFLAX (337D)

TRES PECOS FARMS (338A)

LILLIS RANCH (338B)

DOMENGINE RANCH (338D)

SAN JOAQUIN (359C)

HELM (359D)

TRANQUILLITY (360A)

COIT RANCH (360B)

LEVIS (360C)

CANTUA CREEK (360D)

CHANEY RANCH (361A)

CHOUNET RANCH (361B)

TUMEY HILLS (361C)

MONOCLINE RIDGE (361D)

POSO FARM (381B)

FIREBAUGH (381C)

MENDOTA DAM (381D)

OXALIS (382A)

DOS PALOS (382B)

HAMMONDS RANCH (382C)

BROADVIEW FARMS (382D)

CHARLESTON SCHOOL (383A)

ORTIGALITA PEAK NW (383B)

LAGUNA SECA RANCH (383D)

LOS BANOS VALLEY (384A)

MARIPOSA PEAK (384B)

THREE SISTERS (385A)

SAN FELIPE (385B)

CHITTENDEN (386A)

WATSONVILLE EAST (386B)

DELTA RANCH (402C)

SANTA RITA BRIDGE (402D)

SAN LUIS RANCH (403A)

INGOMAR (403B)

VOLTA (403C)

LOS BANOS (403D)

HOWARD RANCH (404A)

CREVISON PEAK (404B)

PACHECO PASS (404C)

SAN LUIS DAM (404D)

MUSTANG PEAK (405A)

MISSISSIPPI CREEK (405B)

GILROY HOT SPRINGS (405C)

PACHECO PEAK (405D)

MT. SIZER (406A)

MORGAN HILL (406B)

MT. MADONNA (406C)

GILROY (406D)

SANTA TERESA HILLS (407A)

LOS GATOS (407B)

LAUREL (407C)

LOMA PRIETA (407D)

CASTLE ROCK RIDGE (408A)

HATCH (423B)

GUSTINE (423C)

CROWS LANDING (424A)

NEWMAN (424D)

MT. BOARDMAN (425B)

MT. STAKES (425C)

EYLAR MTN (426A)

MT. DAY (426B)

LICK OBSERVATORY (426C)

ISABEL VALLEY (426D)

CALAVERAS RESERVOIR (427A)

MILPITAS (427B)

SAN JOSE WEST (427C)

SAN JOSE EAST (427D)

MOUNTAIN VIEW (428A)

PALO ALTO (428B)

MINDEGO HILL (428C)

CUPERTINO (428D)

County Lists

No county species lists requested.

Key:

- (E) Endangered - Listed as being in danger of extinction.
- (T) Threatened - Listed as likely to become endangered within the foreseeable future.
- (P) Proposed - Officially proposed in the Federal Register for listing as endangered or threatened.
- (NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
- Critical Habitat - Area essential to the conservation of a species.
- (PX) Proposed Critical Habitat - The species is already listed. Critical habitat is being proposed for it.
- (C) Candidate - Candidate to become a proposed species.
- (V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
- (X) Critical Habitat designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, or may be affected by projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.
- During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.
- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.
- Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our critical habitat page for maps.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6580.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be September 17, 2007.

Appendix D

Surface Water Resources Technical Report

Surface Water Resources Technical Report

San Joaquin River Exchange Contractors Water Authority Groundwater Pumping/Transfer Project

Prepared by
Daniel B. Steiner

May 2007

Surface Water Resources Technical Report

San Joaquin River Exchange Contractors Water Authority Groundwater Pumping/Transfer Project

1. Introduction

Through the contract titled Second Amended Contract for Exchange of Waters (the "exchange contract"), the Bureau of Reclamation (Reclamation) provides a substitute water supply to the Central California Irrigation District (CCID), Columbia Canal Company (CCC), San Luis Canal Company (SLCC) and Firebaugh Canal Water District (FCWD) in exchange for waters of the San Joaquin River. Collectively, the four entities are called the "Exchange Contractors". The substitute water amounts to a supply not to exceed 840,000 acre-feet per year in accordance with monthly and seasonal maximum entitlements. During years defined as critical the annual supply is not to exceed 650,000 acre-feet.

The Proposed Action consists of developing up to 20,000 acre-feet of water from components of groundwater pumping, conservation and rotational land fallowing by two of the Exchange Contractors (CCID and FCWD) as a substitute to a like amount of supply delivered by Reclamation to the Exchange Contractors. The water developed from the groundwater component, up to 15,000 acre-feet, would be pumped into the Outside and Main Canals of CCID, blended with other water in the canals and delivered to CCID water users. Water developed by the Proposed Action would reduce the total amount of water delivered by Reclamation to the Exchange Contractors and would be available for Reclamation to deliver to Central Valley Project agriculture and municipal and industrial service contractors. The developed water would appear as a reduction in Reclamation deliveries to CCID and FCWD canals. The Proposed Project would assist in reducing subsurface drain discharges from the area by lowering groundwater levels in the area. This report describes the current hydrologic setting of the surface waters potentially affected by the Proposed Action, and the potential affects of the Proposed Action upon those waters. The focus of the report is the groundwater pumping component's affect on surface waters.

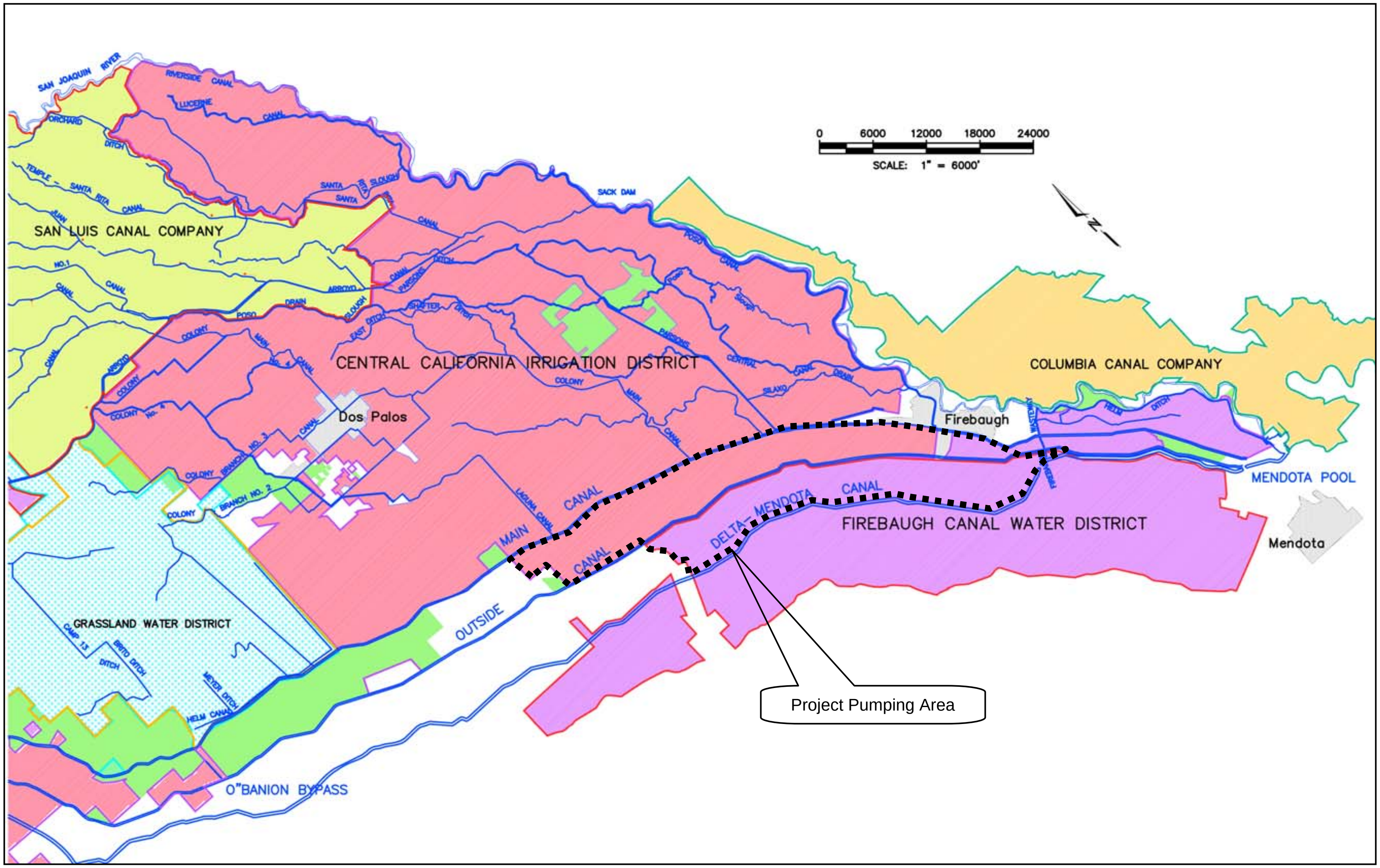
2. Overview of Analysis

The areas that would develop the groundwater component are solely within CCID, including the Camp 13 Drainage Area, and within FCWD. The Proposed Action would involve the development of new and existing wells adjacent to the CCID Outside and Main Canals. Pumping from the wells would blend into these canals' supplies and be delivered downstream. Entities receiving deliveries from or through CCID would experience no change in the quantity of their water supply, but would potentially experience a change in the water quality of their supply. The analysis presented in this report evaluates the potential change in water quality associated with these deliveries as they may be affected by the Proposed Action. A spreadsheet mathematical model is utilized to perform a mass-balance routing of water and water quality for the areas potentially affected by the groundwater component of the Proposed Action. A snapshot of monthly operations and hydrology with and without the Proposed Action is simulated for 5 different types of hydrologic conditions (year types), ranging from critical to wet conditions.

3. Depiction of Existing Operations

The Exchange Contractors provide water deliveries to over 240,000 acres of irrigable land on the west-side of the San Joaquin Valley, spanning a distance from the town of Mendota in the south to the town of Crows Landing in the north. The four entities of the Exchange Contractors each have separate conveyance and delivery systems independently operated, although integrated within a single operation for performance under the exchange contract. These conveyance and delivery systems generally divert water from the CVP Delta Mendota Canal (DMC) and Mendota Pool and convey water to customer delivery turnouts. Deliveries include the conveyance of water to wildlife areas. Figure 1 illustrates the general vicinity of the southern end of the Exchange Contractors' service area, in particular the geographical orientation of the DMC, the Mendota Pool, the southern portion of CCID, and CCID's

Figure 1
Project Vicinity Map
Exchange Contractors – Southern Areas



Outside and Main Canals. Also illustrated is the area where the Proposed Action groundwater pumping would occur and be blended into CCID's canals. CCID currently diverts water from the Mendota Pool into the Outside and Main canals. CCID also receives deliveries from the DMC directly to certain lands and to the Outside Canal at Milepost 76.05 (Wolfsen Bypass). FCWD also receives its water from Reclamation at the Mendota Pool and from turnouts along the DMC.

Both the Outside and Main Canals divert water on a pattern generally representative of seasonal irrigation requirements. Table 1 illustrates recent diversions to the Outside and Main Canals by CCID. This data set is used to provide a representation of non-critical year diversions to the Outside and Main Canals. These diversions are influenced by CCID deliveries to its customers and by conveyance of water to other entities such as the Grassland Water District. During the peak irrigation season (June to August), diversions to the Main Canal can range between 1,000 cfs and 1,800 cfs, and at the Outside Canal can range between 350 cfs and 500 cfs. During critical years[1] diversions to the Outside and Main Canals are reduced due to the reduction in Reclamation supply. Table 2 illustrates the diversions to these canals during 1991 and 1992, years of reduced water supply. This data set provides guidance for the volume and pattern of critical year diversions.

Table 1
Historical CCID Diversions to Main Canal and Outside Canal at Mendota Pool – Non-critical Years

TAF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Main Canal													
2003	5.5	32.3	23.2	15.8	29.4	61.0	74.3	68.8	51.1	35.1	11.3	0.0	407.8
2004	1.5	24.2	26.9	25.3	49.1	55.2	66.3	50.5	33.2	37.9	11.7	2.0	383.7
2005	7.0	16.7	12.7	19.3	32.7	54.6	70.5	63.7	36.9	35.0	15.8	0.0	364.9
Outside Canal													
2003	0.3	8.1	9.9	7.6	10.8	15.6	16.9	16.2	14.2	14.4	4.5	0.0	118.6
2004	1.3	6.1	7.4	8.0	10.2	0.0	12.7	16.0	10.2	11.8	5.9	1.0	90.6
2005	2.0	3.9	14.3	5.5	15.0	23.4	24.2	22.7	21.6	15.6	8.9	0.0	156.9

Table 2
Historical CCID Diversions to Main Canal and Outside Canal at Mendota Pool – Critical Years

TAF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Main Canal													
1991	4.0	14.9	17.1	11.8	28.5	32.2	44.5	36.1	14.7	33.0	22.1	1.8	260.8
1992	0.0	6.6	19.8	14.9	19.1	35.5	37.1	38.7	17.4	34.9	10.3	0.9	235.0
Outside Canal													
1991	4.0	8.6	6.9	5.9	10.3	15.3	20.5	21.3	12.3	9.9	5.9	0.0	120.8
1992	0.1	1.6	5.7	6.7	12.7	13.4	13.0	10.6	16.5	9.5	5.1	0.2	95.1

The quality of water available at the Mendota Pool, and available for diversion to the Outside and Main Canals, is typically indicative of water delivered from the DMC to the Mendota Pool (Check 21). The exception to this condition is when flow from the Tulare Lake Basin enters Mendota Pool through Fresno Slough or when flow enters the pool from the San Joaquin River. The historical record of water quality at Check 21 and at Check 13[2] utilized for this analysis is shown in Exhibit 1. This record was reviewed and analyzed by year type to provide the Mendota Pool water quality parameters described in Table 3 in terms of Electrical Conductivity (EC) expressed in units of micro Siemens per centimeter (uS/cm). These values are incorporated into this analysis as a representation of the water quality available at Mendota Pool and diverted to the Main and Outside Canals for each the five year types.

Water is also delivered to the Outside Canal at DMC milepost 76.05 (Wolfsen Bypass). Water diverted at the Wolfsen Bypass from the DMC can flow either downstream or upstream in the Outside Canal. Recent diversions at the Wolfsen Bypass are shown in Table 4, with the assumed water quality diverted to the

[1] For this analysis a critical year depicts a condition of reduced Reclamation water supply to the Exchange Contractors and CVP customers when the year is defined as a Critical Calendar Year within the Exchange Contract.
[2] Check 13 along the Delta-Mendota Canal experiences water quality associated with the mixing of water diverted at Jones Pumping Plant and water that is released to the Delta-Mendota Canal from O'Neill Forebay (San Luis Unit).

Wolfsen Bypass from DMC Check 13, by year type, shown in Table 5. Water from this source mixes with flow diverted from the Mendota Pool in the Outside Canal, and at times will also mix with flow in the Main Canal through the O'Banion Bypass and other downstream interconnections.

Table 3
Generalized Water Quality Diverted to Main Canal and Outside Canal at Mendota Pool (DMC source)

EC - uS/cm	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mendota Pool												
Wet	500	500	500	460	470	407	334	364	391	398	500	532
Above Normal	550	550	542	463	471	450	355	373	391	491	552	623
Below Normal	556	551	544	469	475	450	365	379	475	537	560	630
Dry	650	615	620	553	480	450	370	485	610	599	572	630
Critical	732	760	814	889	882	766	785	693	699	690	742	780

Based on historical 1993-2004 records, DMC Check 21.

Table 4
Historical CCID Diversion to Outside Canal from Wolfsen Bypass (DMC Milepost 76.05)

TAF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Milepost 76.05													
2003	5.9	8.5	9.0	3.8	20.9	19.1	28.1	22.8	19.9	7.0	7.1	12.1	164.1
2004	10.3	4.9	9.1	8.9	23.1	23.2	27.9	20.4	11.1	11.4	2.0	11.6	164.0
2005	2.0	2.5	5.8	5.1	6.9	15.1	24.6	23.2	16.3	14.4	9.6	12.3	137.8

Based on historical 1993-2004 records, DMC Check 13.

Table 5
Generalized Water Quality Diverted to Outside Canal at DMC Milepost 76.05

EC - uS/cm	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mendota Pool												
Wet	383	370	357	346	298	278	244	271	274	317	406	453
Above Normal	500	507	440	420	438	337	274	289	355	478	528	618
Below Normal	535	546	510	450	443	404	310	356	461	518	540	628
Dry	575	584	586	499	457	409	333	459	582	584	556	630
Critical	588	638	700	642	565	541	564	576	624	600	577	636

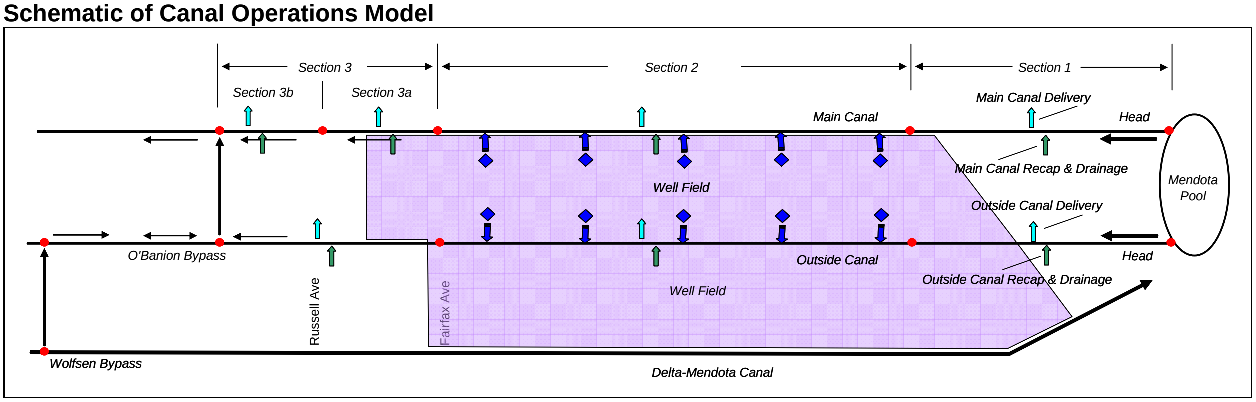
Water diverted at Mendota Pool to the Outside Canal is depleted by deliveries along the canal's downstream path. Accretion inflows will enter the canal from groundwater supplies, surface tailwater recapactured by relift pumps, and minor drainage pumping. Water in the canal continues to flow downstream to the O'Banion Bypass where it can be bifurcated to continue flowing downstream in the Outside Canal and/or be diverted to the Main Canal. Under normal conditions flow originating from the Mendota Pool continues only a short distance downstream past the O'Banion Bypass. At that location, the remainder of the Outside Canal's demands is met with diversions originating from the Wolfsen Bypass. Although variable by CCID operations, the flow through the O'Banion Bypass from the Outside Canal to the Main Canal is assumed to be approximately 50 cfs.

Water diverted at Mendota Pool to the Main Canal is also depleted and supplemented along its downstream path. Deliveries will typically be met from Mendota Pool diversions to a location near Russell Avenue. Northward from that point deliveries may be met from flow continuing from the Main Canal or from flow from the Outside Canal. As just described, the flow from the Outside Canal could originate from either the Mendota Pool or from DMC water routed through the O'Banion Bypass. In the local area along the Main Canal, deliveries are made to numerous community ditches, Grassland Water District and others that receive water through the conveyances of CCID.

4. Routing Model

The Proposed Action consists of pumping up to 15,000 acre-feet of groundwater into the Outside and Main canals, blending that groundwater in the canals and delivering the blended water to downstream locations. To analyze the Proposed Action a mathematical model was developed to evaluate 5 different year type “snapshots” of the potential effects of introducing the groundwater into the canal systems. The results indicate the affect of the introduced water upon delivered water. The model was developed in Microsoft Excel with a depiction of operations during each month of a year, January through December. For a year of operations, the depiction of current hydrologic conditions is established, developing a “baseline” of results to which the Proposed Action will be compared. Such “no-action” hydrologic parameters as the flow and water quality at the headworks of the canals are identified. Deliveries from and accretion inflows entering the canals are also established. The Proposed Action in terms of monthly groundwater pumping (quantity and quality), and the distribution of the pumping among the canals is then identified and incorporated into the model simulation. Results are provided in terms of canal flows and quality at various locations. Figure 2 illustrates a schematic of the model.

Figure 2
Schematic of Canal Operations Model



The model separates the Outside and Main canals’ operation into three general geographical reaches (sections). Section 1 represents the area from the canals’ headworks at Mendota Pool to a location near the town of Firebaugh. The upper-most areas of the Main Canal and the Poso Canal are served in this section. This section along the Outside Canal would be upstream of Proposed Action pumping. Within this area canal flow would be depleted due to local deliveries and supplemented by existing groundwater pumping, tailwater recapture and drainage pumping. The flow and water quality at the end of Section 1 is computed as the blend of diversions at the headworks and canal supplemental supplies, depleted by canal deliveries. The protocol for calculating conditions at the end of Section 1 assumes that canal deliveries are depleted at the most downstream point in the section, removing water from the canal at a water quality equal to the blend of headworks diversions and supplemental supplies.

Section 2 generally represents the reach of each canal where the Proposed Action pumping would occur. This area begins at the end of Section 1 and continues to a location at the northern end of the proposed well field, near Fairfax Avenue. The model incorporates existing supplemental supplies to the canals and deliveries for this reach also. Proposed Action groundwater pumping is selected for the operation which requires the identification of the annual quantity of pumping, its monthly distribution and quality, and the relative amount of pumping delivered to the Main Canal and Outside Canal. The flow and water quality at the end of Section 2 is computed as the blend of flow from Section 1 and canal supplemental supplies, depleted by canal deliveries, and supplemented with Proposed Action pumping. The protocol for calculating conditions at the end of Section 2 again assumes that canal deliveries are depleted at the most downstream point in the section, removing water from the canal at a water quality equal to the blend of flow from Section 1, supplemental supplies and Proposed Action pumping.

Section 3 represents the canals’ condition downstream of the well field. This section is modeled to represent the quality of water delivered from the canals as it may be affected by the Proposed Action and blended with supplies from the DMC. Section 3 for the Outside Canal represents an area beginning at the end of Section 2 and continues downstream to the O’Banion Bypass. At that point Outside Canal flow mixes with Outside Canal flow originating from the DMC from the turnout at Milepost 76.05 (Wolfsen Bypass). For the Main Canal, Section 3 has been disaggregated into Section 3a and Section 3b. Section 3a represents the area beginning at the end of Section 2 and continues to a location near Russell Avenue (a location near the northern-most turnout of CCID's southern service area). Section 3b begins at this point and continues to the connection with the O'Banion Bypass. Section 3b generally represents an area where turnouts to the Grassland Water District occur (representing a demand pattern indicative of wildlife management areas).

5. Scenario Hydrologic Assumptions

Several hydrologic parameters are assumed for this analysis. The operation of Proposed Action pumping and CCID's canals could vary from year-to-year depending upon available supplies, weather conditions, maintenance needs, conveyance commitments and objectives for the quality of water delivered. A "most typical" scenario has been developed to illustrate the potential water quality effects of the Proposed Action.

5.1 Proposed Action Pumping

The Proposed Action develops up to 15,000 acre-feet of groundwater pumping as a substitute supply for Reclamation's deliveries to CCID.[3] The Proposed Action anticipates the patterning of groundwater pumping to direct impacts to certain areas and minimize the water quality effect to all other areas. In this scenario, the majority of water quality effect of the Proposed Action is directed to the Section 2 area of the Outside Canal, the area associated with the drainage to be reduced. This effect would be accomplished by pumping the Proposed Action groundwater component volume (15,000 acre-feet) into Section 2 of the Outside Canal. The groundwater pumping would occur in a pattern that is conducive to blending with deliveries from the DMC and Mendota Pool. The model was iteratively executed to test alternative distributions of Proposed Action pumping, ultimately deriving a pattern that produces a generally constant quality of water in Section 2 within a year during the period Proposed Action pumping. The derived patterns vary by year type, as the primary source water of the canals (Mendota Pool) varies. No pumping into the Main Canal is assumed for the typical operation; however, opportunities may occur when pumping to the Main Canal works within CCID objectives. Table 6 depicts the monthly pattern assumed for up to 15,000 acre-feet of Proposed Action groundwater pumping. The assumed water quality of the pumping (3,200 uS/cm) equates to approximately 2,000 part per million (ppm) Total Dissolved Solids (TDS).

Table 6
Proposed Action Groundwater Pumping

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Outside Canal													
Volume - TAF													
Wet	0.0	0.0	0.8	0.8	1.4	2.5	2.9	2.8	2.1	1.8	0.0	0.0	15.0
Above Normal	0.0	0.0	0.7	0.9	1.5	2.4	3.0	2.9	2.2	1.5	0.0	0.0	15.0
Below Normal	0.0	0.0	0.8	1.0	1.6	2.5	3.0	3.0	1.8	1.4	0.0	0.0	15.0
Dry	0.0	0.0	0.7	0.9	1.7	2.9	3.5	2.6	1.4	1.4	0.0	0.0	15.0
Critical	0.0	0.0	1.1	0.8	1.5	2.6	2.9	3.3	0.8	2.0	0.0	0.0	15.0
Flow - CFS													
Wet	0	0	12	14	22	42	48	45	35	29	0	0	
Above Normal	0	0	11	15	24	40	49	46	37	24	0	0	
Below Normal	0	0	12	16	26	42	49	49	30	23	0	0	
Dry	0	0	11	15	28	48	56	43	24	22	0	0	
Critical	0	0	17	14	24	44	48	54	14	32	0	0	
EC - uS/cm	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	

[3] The Proposed Action would develop up to 20,000 acre-fee of water for transfer, up to 15,000 acre-feet from groundwater pumping into CCID's canals. The remaining 5,000 acre-feet of transfer water would be developed through conservation and rotational land fallowing. A large portion of the 5,000 acre-feet of would be developed within FCWD which would not affect the diversions assumed in the analysis of CCID's canal operation. The small portion of the 5,000 acre-feet developed in CCID's service area has not been included in the modeling, and if modeled would have a very small and inconsequential affect upon the results presented.

5.2 Canal Deliveries and Supplemental Supplies

Existing groundwater pumping, tailwater recapture, drainage pumping and deliveries are defined for each canal section. Table 7 depicts these hydrologic parameters for non-critical years, which are assumed to be the same for both the baseline and the Proposed Action condition. During critical years the canal water deliveries are assumed to be reduced to approximately 77 percent of the non-critical year volumes. This proportion represents the ratio of critical year Exchange Contract annual entitlements (650,000 acre-feet) to non-critical year entitlements (840,000 acre-feet).

Table 7
Canal Supplemental Supplies and Deliveries – Non-critical Years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Main Canal												
Section 1												
Supply - CFS	0	7	7	8	15	21	25	21	8	3	1	0
Supply - EC	NA	935	936	922	915	905	887	914	934	932	926	NA
Delivery	0	13	14	15	29	41	50	42	15	5	3	0
Section 2												
Supply - CFS	0	5	6	6	12	17	20	17	6	2	1	0
Supply - EC	NA	676	682	608	574	527	437	569	671	659	629	NA
Delivery	0	143	158	167	322	455	550	459	170	56	32	0
Section 3a												
Supply - CFS	0	1	1	2	3	4	5	4	2	1	0	0
Supply - EC	NA	676	682	608	574	527	437	569	671	659	629	NA
Delivery	0	13	14	15	29	41	50	42	15	5	3	0
Section 3b												
Supply - CFS	0	0	0	0	0	0	0	0	0	0	0	0
Supply - EC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Delivery	74	56	35	36	105	66	28	114	350	264	104	68
Outside Canal												
Section 1												
Supply - CFS	0	5	6	6	12	17	20	17	6	2	1	0
Supply - EC	NA	757	761	706	681	645	578	677	753	744	722	NA
Delivery	0	13	14	15	29	41	50	42	15	5	3	0
Section 2												
Supply - CFS	0	4	4	5	9	12	15	13	5	2	1	0
Supply - EC	NA	676	682	608	574	527	437	569	671	659	629	NA
Delivery	0	31	34	37	70	99	120	100	37	12	7	0
Section 3												
Supply - CFS	0	0	0	0	0	0	0	0	0	0	0	0
Supply - EC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Delivery	0	13	14	15	29	41	50	42	15	5	3	0

Note: Supply represents the combination of existing groundwater pumping, tailwater relift and drainage pumping. EC is displayed in uS/cm.

5.3 CCID Diversions

Variable from year-to-year, Table 8 illustrates the non-critical year no action diversions from the Mendota Pool to the Main Canal and Outside Canal assumed for this analysis. These diversions are reduced in the Proposed Action condition by the amount of Proposed Action pumping. Table 9 illustrates the data set

Table 8
Without Project Main Canal and Outside Canal Diversions from Mendota Pool – Non-critical Years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Main Canal													
TAF	0.0	24.0	24.0	24.0	38.0	59.2	73.2	63.2	42.0	38.0	14.4	0.0	400.0
CFS	0	432	390	403	618	995	1,190	1,028	706	618	242	0	
Monthly Dist %	0.0	6.0	6.0	6.0	9.5	14.8	18.3	15.8	10.5	9.5	3.6	0.0	
Outside Canal													
TAF	0.0	9.0	9.0	9.0	15.0	22.5	22.5	22.5	17.3	15.8	7.5	0.0	150.0
CFS	0	162	146	151	244	378	366	366	290	256	126	0	
Monthly Dist %	0.0	6.0	6.0	6.0	10.0	15.0	15.0	15.0	11.5	10.5	5.0	0.0	

assumed for critical year diversions. The monthly pattern of these assumed diversions has been adjusted from the observed historical pattern to reflect an assumption of canal or Mendota Pool maintenance during December and January.

Table 9
Without Project Main Canal and Outside Canal Diversions from Mendota Pool – Critical Years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Main Canal													
TAF	0.0	18.6	18.6	18.6	29.4	43.3	51.1	46.4	24.8	40.2	18.6	0.0	309.5
CFS	0	335	302	312	478	728	830	755	416	654	312	0	
Monthly Dist %	0.0	6.0	6.0	6.0	9.5	14.0	16.5	15.0	8.0	13.0	6.0	0.0	
Outside Canal													
TAF	0.0	7.0	7.0	7.0	12.2	15.7	18.6	17.4	15.1	10.4	5.8	0.0	116.1
CFS	0	125	113	117	198	263	302	283	254	170	98	0	
Monthly Dist %	0.0	6.0	6.0	6.0	10.5	13.5	16.0	15.0	13.0	9.0	5.0	0.0	

6. Results

The Proposed Action is depicted by modeling 5 water year type snapshots of a typical anticipated operation of CCID's canals and the proposed groundwater pumping. The Proposed Action would occur every year, providing up to an additional 15,000 acre-feet of groundwater pumping into the supply system of CCID. The pattern in which Proposed Action pumping would operate in a year could likely be somewhat different than depicted by the modeling, and would be dependent upon then-existing hydrologic conditions. The varying conditions that could influence the operation of the project would include the quality of water delivered by Reclamation at Mendota Pool, water demands and the desired quality of the water provided to CCID's customers.

Results of this analysis focus on the change in the quality of water delivered by CCID at various locations along its Outside Canal and Main Canal. The amount of water delivered by CCID would remain the same as delivered without the Proposed Action. Diversions to the Outside Canal and Main Canal (if pumping occurs into the Main Canal) from Mendota Pool would be reduced by the amount of pumping into those facilities.

6.1 Lower DMC and Mendota Pool

No change in water quality in the Lower DMC or Mendota Pool would occur since the groundwater pumping of the Proposed Action enters only CCID's Outside and Main Canals. The lower DMC and Mendota Pool continue to provide source water for CCID's canals.

6.2 Upper-most Reach of Outside Canal, and Main Canal to Approximately Russell Avenue

In the areas served by CCID's Outside Canal between the headworks of the canal at Mendota Pool and the upper (southern) end of the proposed well field (Section 1) no change in water quality is anticipated since there is no Proposed Action pumping in this reach. No change in quality would occur in the Main Canal from its headworks at Mendota Pool to a downstream location where its flow commingles with flow originating from the Outside Canal through the O'Banion Bypass. Modeled Main Canal operations result in a positive flow past Section 2 and Section 3a at Russell Avenue in all years. These model sections are assumed to serve CCID's southern service area agricultural customers.

6.3 Outside Canal adjacent to Proposed Action Well Field

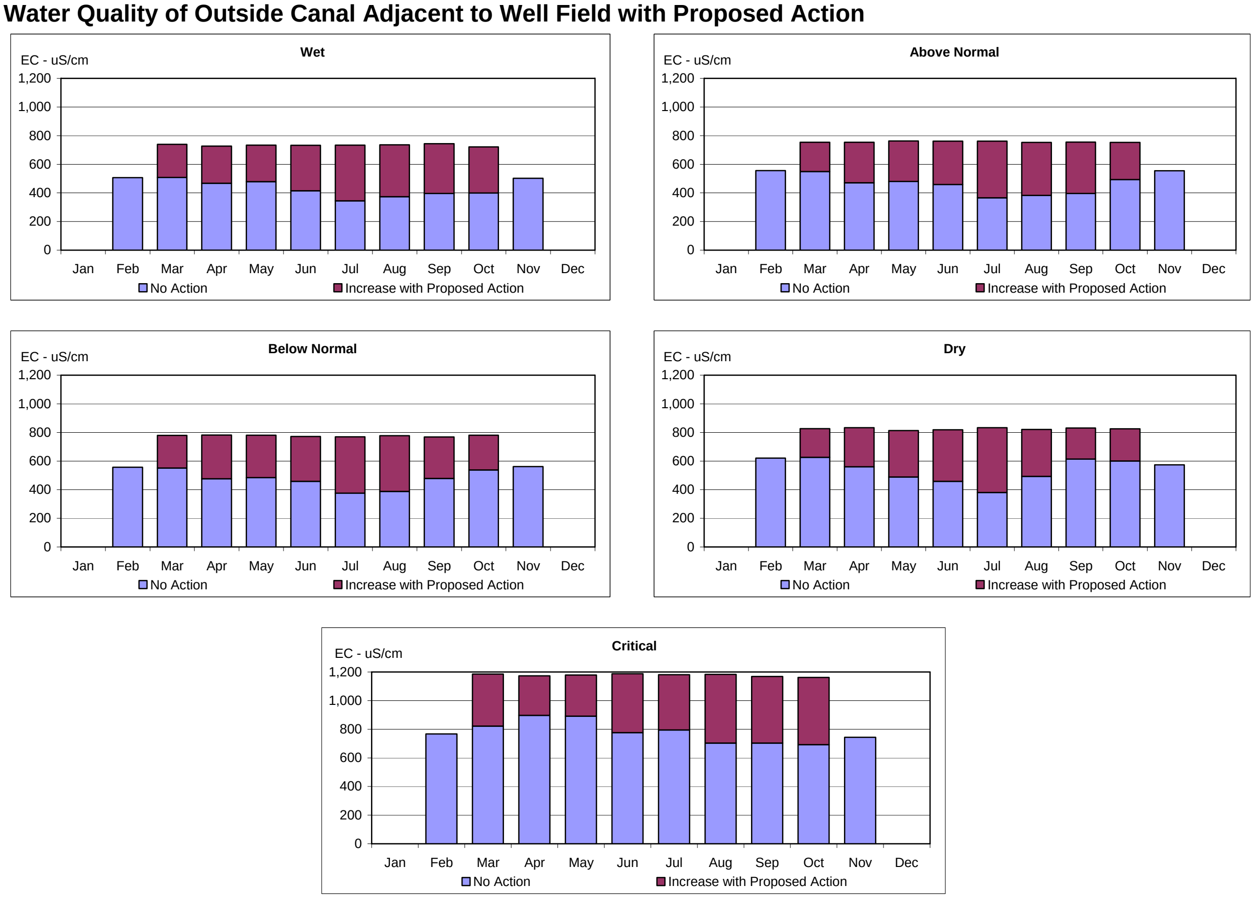
The Proposed Action well field adjacent to the Outside Canal is assumed to be situated from approximately the Firebaugh Wasteway, north to mid-way between Fairfax and Laguna avenues. The area is represented by Section 2 of the model. The water delivered from Outside Canal in this area would be affected by Proposed Action pumping into the canal within Section 2. The projected change in water quality within Section 2 is shown in Table 10, and graphically illustrated in Figure 3.

The results illustrate achieving the operational objective to provide a generally constant level of quality for the water delivered to the area during the period of Proposed Action pumping. Results are not shown for January and December as it is assumed that the Outside Canal or Mendota Pool will undergo maintenance during that period of time.

Table 10
Projected Water Quality of Outside Canal Adjacent to Well Field with Proposed Action

EC - uS/cm	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No-action												
Wet		506	507	468	479	415	345	374	396	399	502	
Above Normal		556	549	471	480	458	366	383	395	493	554	
Below Normal		557	551	477	484	458	376	388	479	538	562	
Dry		621	627	560	489	458	381	493	614	601	574	
Critical		767	822	897	891	776	796	703	703	692	744	
Action												
Wet		506	739	727	734	733	733	735	743	721	502	
Above Normal		556	754	753	763	762	761	753	755	753	554	
Below Normal		557	779	782	781	771	770	778	768	781	562	
Dry		621	826	833	813	819	833	821	831	825	574	
Critical		767	1,185	1,173	1,179	1,188	1,181	1,183	1,168	1,162	744	
Difference												
Wet		0	232	259	255	318	388	362	347	322	0	
Above Normal		0	205	282	283	303	395	371	360	260	0	
Below Normal		0	228	305	297	313	394	389	289	242	0	
Dry		0	199	273	324	360	452	328	217	224	0	
Critical		0	363	276	288	412	385	480	465	470	0	

Figure 3
Water Quality of Outside Canal Adjacent to Well Field with Proposed Action



Proposed Action pumping has been assumed to be scheduled during the March through October period. Best water quality is projected to occur during wet years with the quality estimated to be approximately 730 uS/cm EC (470 TDS), decreasing in quality in drier years to approximately 830 uS/cm EC (530 TDS). During critical years it is projected that water quality could reach 1,180 uS/cm EC (755 TDS). The critical year result is affected by both the lesser water quality available at the Mendota Pool and by the Proposed Action pumping affecting a smaller amount of canal diversions during critical years.

6.4 Outside Canal downstream of Well Field

CCID deliveries from Outside Canal downstream of the well field cease until reaching a location downstream of the O'Banion Bypass. Modeled operations for the Outside Canal indicate a positive flow downstream of the well field in all years, except when there is no flow in the canal due to maintenance during January and December. The quality of the water in Outside Canal downstream of the well field would be approximately the same as the quality leaving Section 2 (shown in Table 10). The flow in the Outside Canal is assumed to be diverted to the Main Canal through the O'Banion Bypass up to a rate of 50 cfs, with any remaining flow continuing downstream in the Outside Canal.

Table 11 shows the modeled flow in the Outside Canal just upstream of the O'Banion Bypass. The first 50 cfs of this flow is assumed to be diverted through O'Banion Bypass to the Main Canal. The remainder of the flow would continue downstream in the Outside Canal. The location at which the flow in the Outside Canal transitions from being supplied from Mendota Pool to being supplied from DMC Milepost 76.05 (Wolfsen Bypass) would vary. No supplies enter the Outside Canal between the downstream location of the well field and O'Banion Bypass which results in the water quality at this location being the same as shown in Table 10.

Table 11
Outside Canal Flow upstream of O'Banion Bypass

Flow - cfs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action												
Wet	0	114	93	95	135	225	181	212	233	237	115	0
Above Normal	0	114	93	95	135	225	181	212	233	237	115	0
Below Normal	0	114	93	95	135	225	181	212	233	237	115	0
Dry	0	114	93	95	135	225	181	212	233	237	115	0
Critical	0	90	74	76	119	151	167	170	212	156	90	0
Action												
Wet	0	114	93	95	135	225	181	212	233	237	115	0
Above Normal	0	114	93	95	135	225	181	212	233	237	115	0
Below Normal	0	114	93	95	135	225	181	212	233	237	115	0
Dry	0	114	93	95	135	225	181	212	233	237	115	0
Critical	0	90	74	76	119	151	167	170	35	156	90	0
Difference												
Wet		0	0	0	0	0	0	0	0	0	0	
Above Normal		0	0	0	0	0	0	0	0	0	0	
Below Normal		0	0	0	0	0	0	0	0	0	0	
Dry		0	0	0	0	0	0	0	0	0	0	
Critical		0	0	0	0	0	0	0	-176	0	0	

The flow in the Outside Canal upstream of the O'Banion Bypass location is the same in the no action and Proposed Action scenarios except for one instance in critical years. During that period CCID diversions were shifted in September from the Outside Canal to the Main Canal with a compensating shift in pumping to other months to achieve the directed water quality effect along the Outside Canal while minimizing the effect on Main Canal deliveries. The quality of the flow remaining in the Outside Canal will be approximately the same as shown in Table 10 until fully depleted by downstream deliveries.

The results illustrate the potential flexibility in pumping strategy that could provide a managed range of water quality during the year. Flexibility will be available in shifting pumping and canal diversions from period-to-period, and among the canals to achieve desired delivered water quality conditions. An increase in pumping rate capacity for the Proposed Action could provide additional flexibility to blending operations.

6.5 Main Canal below Russell Avenue

The Main Canal is disaggregated into two areas representing Section 3. Section 3a represents an area downstream of the well field where the deliveries are associated with CCID's agriculture irrigators. This area is generally downstream of Fairfax Avenue and ends approximately at Russell Avenue. Section 3b represents the area downstream of Section 3a and continues to the O'Banion Bypass. Within this area deliveries occur to the Grassland Water District. The water quality of flow leaving Section 3a would be generally indicative of diversions from Mendota Pool (see Table 3) and would be unaffected by the Proposed Action. The projected water quality in Section 3b for the baseline and the Proposed Action scenarios would also be the same. During January and December when maintenance may occur upstream of Section 3b water may be delivered to the area from O'Banion Bypass, but these deliveries would be unaffected by the Proposed Action since headwork diversions and Proposed Action pumping are not occurring.

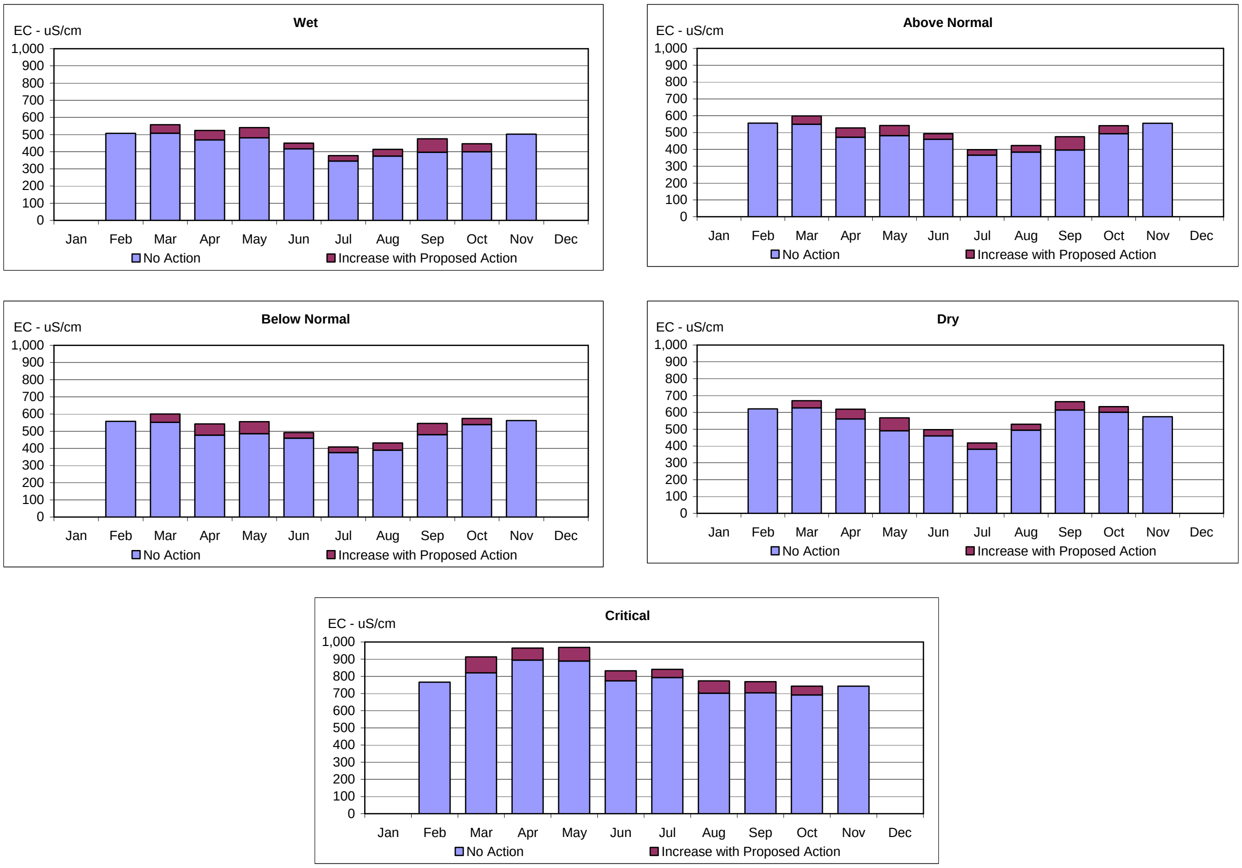
There normally would be a positive flow of water past Section 3b, with supplemental flow from the O'Banion Bypass adding to the supply of the Main Canal for downstream deliveries. As described above flow from the O'Banion Bypass comes from the Outside Canal either originating from the Mendota Pool or, when no flow is available from upstream Outside Canal, from the DMC via the Outside Canal from the Wolfsen Bypass. The quality of the water in Main Canal below the O'Banion Bypass with and without the Proposed Action is shown in Table 12, and illustrated in Figure 4.

Table 12
Main Canal below O'Banion Bypass Water Quality

EC - uS/cm	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action												
Wet		507	508	469	481	417	346	375	397	400	502	
Above Normal		556	549	472	481	460	366	384	396	493	555	
Below Normal		557	552	477	486	460	376	390	480	539	562	
Dry		621	627	560	490	460	381	494	614	601	574	
Critical		766	821	894	889	774	793	702	703	691	743	
Action												
Wet		507	558	524	541	450	377	414	476	447	502	
Above Normal		556	593	532	548	491	398	424	478	531	555	
Below Normal		557	600	542	556	492	408	432	545	574	562	
Dry		621	669	619	567	497	418	529	663	634	574	
Critical		766	913	965	968	832	841	773	769	743	743	
Difference												
Wet		0	50	55	60	33	32	39	79	47	0	
Above Normal		0	44	60	67	31	32	40	82	38	0	
Below Normal		0	49	65	70	32	32	42	66	35	0	
Dry		0	43	58	77	37	37	35	49	33	0	
Critical		0	93	70	79	59	47	71	66	52	0	

Generally the flow in Main Canal below O'Banion Bypss could experience a lessening in water quality due to the Proposed Action ranging between 30 and 70 uS/cm EC (20-50 ppm TDS) during March through October during non-critical years, and up to 100 uS/cm EC (approximately 65 ppm TDS) during critical years. The water quality effect could be alternatively managed by the flexibility available to shift pumping from month-to-month, and by alternatively managing the diversions at CCID's Outside and Main canals and flow through the O'Banion Bypass.

Figure 4
Main Canal below O'Banion Bypass Water Quality



7. Additional Water Quality Effects

CCID is geographically and conveyance interconnected to other lands and purveyors in the area. Its operation in relation to surface water resources in the region are described in the EIS/EIR titled "Water Transfer Program for the San Joaquin River Exchange Contractors Water Authority 2005-2014", dated December 2004 (Transfer Report). A change in the quality of water delivered by CCID could have a varying affect to areas within and adjacent to CCID.

The results of this analysis indicate the changes in water quality that could occur to water delivered at various locations along CCID's system, and have been illustrated above. The effect of these changes within the disposition of the delivered water is described as follows.

7.1 Deliveries Adjacent to Section 1

For areas receiving water from CCID's Main Canal in Section 1 and other diversions from the Mendota Pool, there would be no change in water quality since Proposed Action pumping enters CCID's system downstream of these locales.

7.2 Deliveries Adjacent to Section 2

The delivery area of Outside Canal in Section 2 is downslope-bound by the Main Canal and thus surface water within this area is isolated from adjacent areas. Surface water deliveries are applied to the lands with percolation occurring to the groundwater. Surface water tailwater within the area, although minor, is captured by CCID through re-lift pumping into the Main Canal. At the peak of the irrigation season, the re-lift of tailwater may be 2-3 percent of the flow in the Main Canal, and degrades the quality of water in the Main Canal by less than 5 uS/cm (without the Proposed Action). The lessening of water quality in surface water supply to the area (generally a maximum degradation of less than 400 uS/cm EC, see Table 10) with subsequently affected tailwater from this source would not change this result.

Major deliveries by CCID from the Main Canal in Section 2 include releases to the Parsons Canal and Colony Main Canal. These canal systems serve areas in CCID's southern area. Since the water quality in the Main Canal in Section 2 is unaffected by the Proposed Action no change in the source water of CCID's southern area would occur.

7.3 Deliveries Adjacent to Section 3

The delivery area of Outside Canal in Section 3 is also downslope-bound by the Main Canal and thus also isolated from adjacent areas. The deliveries in this area are about 50 cfs during the peak of the irrigation season. Surface water deliveries are applied to the lands, with percolation occurring to the groundwater. No tailwater in this area is currently captured by CCID through re-lift pumping into the Main Canal, thus any effect caused by a lessening in the quality of the water source supply to this area (generally a maximum degradation of less than 400 uS/cm EC) manifests within the area. Deliveries of water from the Main Canal in Section 3a and Section 3b will be unaffected.

7.4 Deliveries Below O'Banion Bypass

As described previously, water in the Outside Canal that originates from Mendota Pool and is degraded by the Proposed Action pumping may at times continue downstream of O'Banion Bypass for some distance until depleted by deliveries in CCID's northern area. The areas served with this water are upslope of the Main Canal, and except for tailwater re-lift pumping into the Main Canal (minor in quantity) would not affect other surface water resources.

The quality of water deliveries from the Main Canal below O'Banion Bypass is projected to be affected by the Proposed Action (see Table 12). The effect could be a degradation of quality ranging from minimal to about 90 uS/cm EC. Agricultural lands receiving this water (CCID's northern area) have little or no surface water connectivity with the San Joaquin River (see Transfer Report). The additional loading from the supplies will have effects that manifest within the area's lands.

7.5 San Joaquin River Outfalls

Since the Proposed Action does not affect the quality of water provided to CCID's southern area or the wildlife management areas served adjacent to CCID's southern area, nor does the quality of water used by other diverters of Mendota Pool change, there is no change in water quality anticipated to the outflow of water from the area to the San Joaquin River.

Exhibit 1
Recorded Water Quality
Delta- Mendota Canal at Selected Locations

DMC Check 13 uS/cm													40-30-30 Index	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Type	Index
1998	422	347	408	287	228	168	152	251	222	204	280	382	W	13.31
1995	464	417	390	246	170	189	225	313	268	208	358	373	W	12.89
1997	187	215	313	377	369	328	246	228	164	396	473	538	W	10.82
1996	455	366	321	381	359	337	306	288	301	311	387	276	W	10.26
1999	388	223	353	438	364	370	289	278	415	464	530	695	W	9.8
2000	548	489	330	384	425	369	304	302	358	457	524	619	AN	8.94
2003	562	526	550	457	450	304	244	276	351	500	532	617	AN	8.18
2004	535	546	510	416	443	404	344	356	461	518	524	628	BN	7.5
2002	527	577	585	486	459	402	317	442	561	576	556	614	D	6.35
2001	705	591	587	512	456	416	349	476	603	592	557	603	D	5.76
1994	588	638	747	642	565	541	564	576	624	536	577	636	C	5.02

DMC Check 20 uS/cm													40-30-30 Index	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Type	Index
1998	608	1,193	977	707	547	531	292	270	249	259	376	520	W	13.31
1995	889	616	1,090	736	771	577	307	340	341	245	421	543	W	12.89
1997	412	779	369	425	405	378	318	335	378	483	602	NR	W	10.82
1996	639	438	743	468	492	329	319	324	339	312	384	444	W	10.26
1999	463	280	388	522	385	NR	NR	310	NR	NR	562	873	W	9.8
2000	1,094	577	552	444	460	413	349	334	380	489	488	513	AN	8.94
2003	627	563	604	507	491	323	301	324	362	505	517	709	AN	8.18
2004	631	565	569	461	460	435	371	379	472	547	533	629	BN	7.5
2002	636	599	625	521	484	444	339	472	582	598	573	656	D	6.35
2001	538	550	624	581	484	450	384	516	651	622	575	665	D	5.76
1994	724	711	858	830	779	682	709	648	650	648	726	883	C	5.02

DMC Check 21 uS/cm													40-30-30 Index	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Type	Index
1998	711	1,145	1,074	819	644	569	336	350	346	359	447	442	W	13.31
1995	487	612	1,300	633	729	210	274	400	353	246	419	522	W	12.89
1997	332	300	485	490	475	452	380	392	427	542	642	649	W	10.82
1996	646	475	549	416	377	389	358	374	386	348	438	506	W	10.26
1999	526	368	387	518	386	412	322	306	446	493	553	540	W	9.8
2000	609	573	496	440	461	399	332	335	378	492	529	631	AN	8.94
1993						648	479	429	428	469	578	672	AN	8.54
2003	623	560	588	487	481	303	253	357	366	513	551	566	AN	8.18
2004	556	551	544	469	468	438	365	379	475	537	540	737	BN	7.5
2002	630	590	621	517	469	435	333	465	580	600	569	645	D	6.35
2001	726	640	618	588	491	445	364	505	640	598	575	615	D	5.76
1994	732	760	814	889	882	766	785	693	699	690	742	924	C	5.02

Source:
Central Valley Operations Office Database. Arranged by water year in descending order of Sacramento 40-30-30 Index.

Appendix E

Socioeconomics Technical Report

D R A F T

SOCIOECONOMICS TECHNICAL REPORT

for the

San Joaquin River Exchange Contractors Water Authority Groundwater Pumping/Water Transfer Project

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June 25, 2007

TABLE OF CONTENTS

Section **Page**

ATTACHMENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AF	Acre Feet
AFY	Acre Feet per Year
CCID	Central California Irrigation District
CEQA	California Environmental Quality Act
CVP	Central Valley Project
DMC	Delta-Mendota Canal
FCWD	Firebaugh Canal Water District
I-O	Input-Output
M&I	Municipal and Industrial
NAICS	North American Industrial Classification System
NEPA	National Environmental Policy Act
O&M	Operations and Maintenance
SIC	Standard Industrial Classification
SCVWD	Santa Clara Valley Water District
SLWD	San Luis Water District

SOCIOECONOMICS TECHNICAL REPORT[1]

INTRODUCTION

This technical appendix analyzes the socioeconomic impacts of alternatives proposed for the annual transfer of up to 20,000 acre-feet (AF) of substitute[2] water from the San Joaquin River Exchange Contractors Water Authority (Exchange Contractors) to other Central Valley Project (CVP) water contractors. The program would be in place over a 25-year period, possibly beginning in 2008. The substitute water from the Delta-Mendota Canal (DMC) would be replaced within the Exchange Contractors' service area by water from three potential sources: (1) groundwater pumping, (2) conservation (including canal lining, drip irrigation, and other source and drain water control measures that would result in a savings of water to a saline sink), and (3) land fallowing (where it would benefit or control shallow groundwater levels). Under the Proposed Action/Proposed Project, the primary source of water that would allow for the transfer of surface water supplies would be groundwater substitution; water from conservation measures would be used if groundwater supplies are unavailable, and land fallowing would be implemented only if supplies from the other two sources are inadequate. The direct application of the pumped groundwater to CCID agricultural lands would free up commensurate Delta Mendota Canal water supplies for transfer to other CVP contractors.

The purpose of the Proposed Action/Proposed Project (called the Proposed Action hereafter) is to develop a water supply within Firebaugh Canal Water District (FCWD) and the Camp 13 Drainage Area of Central California Irrigation District (CCID), which will permit transfer of Exchange Contractors water to other agencies and which will help alleviate their respective water supply shortages. FCWD and the Camp 13 area of CCID are adversely affected by current shallow groundwater levels that extend to the crop root zone. Both districts need to take measures to control the depth to groundwater in order to maintain agricultural viability in this area. The developed water supply within FCWD and CCID would be blended with surface water and utilized within other parts of CCID.

Specifically, the objectives of the proposed water development activity and transfer are as follows:

- Make water available for beneficial use by other CVP agricultural and municipal and industrial (M&I) water service contractors in the San Luis and San Felipe Divisions;
- Ensure that groundwater, surface water, and conserved water in the Exchange Contractors' service area are managed conjunctively to maximize beneficial use;
- Achieve a long-term, sustainable salt and water balance in the root zone of irrigated lands in the affected areas in FCWD and CCID; and
- Provide for the management of the saline sink underlying the plan area to prevent its migration downslope.

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[1] The information in this technical appendix is summarized in Section 3.6 (Affected Environment) and Section 4.6 (Environmental Consequences) of the Draft EA/IS.

[2] Substitute water is so named because the Exchange Contractors' water supply from the Delta Mendota Canal substitutes for surface water diversions from the San Joaquin River in most years.

The proposed transfer would allow for the delivery up to 20,000 AF per year (AFY) of DMC water to any or all of the following users:

- The CVP provides up to 152,500 AFY to SCVWD (119,400 AFY for M&I needs and 33,100 AFY for agricultural needs). (Reclamation 1977, 2004e)
- For SLWD, the CVP provides up to 125,080 AF (2,000 AFY for M&I needs and 123,080 AFY for agricultural needs). (Reclamation 2005b)

The proposed groundwater pumping program would include up to 15 new wells and 5 existing wells, all using diesel pumps.

Overview of the Socioeconomic Analysis

This socioeconomic analysis relates only to the economic impacts of the proposed transfer within the Exchange Contractors' service area. Economic impacts, if any, in the geographic areas of the districts receiving the transferred water are not included in this technical report, but are referenced in the Draft EA/IS.

Socioeconomic analyses typically include two types of investigations. The first is a social analysis, which focuses on demographic and related parameters that could potentially be affected by the alternatives; it typically also includes an evaluation of environmental justice considerations. The second is a regional economic analysis, which considers principal production (output), employment, and income variables in the economic study area and related effects on fiscal resources; these effects are estimated using regional input-output (I-O) analysis[3]. This focus of this report is on regional economic impacts; other social and fiscal effects are evaluated in the Draft EA/IS.

The primary impact variables of interest within the Exchange Contractors' service area are net farm income; regional output, income, and employment; and revenues and expenditures associated with the Exchange Contractors themselves. Net farm income is influenced by many factors such as crop acreages and prices, costs of production (including water and energy for pumping), crop yields, government programs, and costs of fertilizers, chemicals and other inputs.

Net farm income and regional output, income, and employment may be influenced by both the No Action and Action Alternatives in this study. Under the No Action Alternative, shallow groundwater levels in FCWD and the Camp 13 area of CCID would eliminate agricultural viability. Under the Action Alternatives, although agricultural production could continue, the program may lead to changes in costs of production, yields, and other variables, thus to changes in net farm income.

The revenues and costs of the Exchange Contractors are also likely to be affected by the program. The Exchange Contractors would receive revenues from the water provided to other CVP contractors; and would expend those revenues for a variety of efficiency-improving and related conservation measures, as well as the operation and maintenance of improvements identified in the Westside Regional Drainage Plan. The Exchange Contractors would also expend funds for drilling several new wells and upgrading others within the area from which groundwater would be pumped, in addition to related operations and maintenance (O&M) costs.

[3] See Attachment A for a discussion of the input-output methodology used to estimate regional impacts in this study.

1.0 ENVIRONMENTAL SETTING

Member districts of the Exchange Contractors include, in addition to FCWD and CCID, the San Luis Canal Company and Columbia Canal Company. The four agencies are within Stanislaus, Merced, Madera, and Fresno Counties. These four counties represent the study area for the regional economic impact analysis; this analysis is conducted at the four-county level because of the linkages between activities in the Exchange Contractors service area and the rest of the regional economy.

While the groundwater would be pumped from FCWD and the Camp 13 area within Fresno County, it would be blended with surface water for use in part of the CCID service area in Fresno and Merced counties. Because farms in this two-county area purchase inputs from and sell products in a larger "functional economic area", which include Stanislaus and Madera counties, the regional economic analysis addresses changes in economic activity over the four-county area.

This section begins with a demographic overview of the four-county area, including measures of population, employment, and income. It also includes a review of agriculture within the Exchange Contractors service, as well as the entire four-county region.

1.1 Demographics

This section provides an overview of the demographic characteristics of the four-county study area, focusing on population, income, and race/ethnicity. Demographic parameters which represent economic indicators of social well being, such as per-capita income, poverty rates and unemployment, are addressed within the related topics of income and employment as part of the discussion of the region's economic base. Other demographic characteristics, such as age and gender, are not pertinent to the Proposed Action, and therefore are not discussed here.

1.1.1 Population

The four-county study area represents a substantial component of the Central Valley's population base. As shown in Table 1, there were over 1.7 million people living within these four counties in 2004 (California Department of Finance 2002, 2005a). Most of this population is concentrated in the northern (Stanislaus County) and southern (Fresno County) portions of the study area. By population, Fresno County is the largest of the four counties, at approximately 884,500 people, and accounting for about half (50 percent) of the study area total. It is followed by Stanislaus County (504,500), Merced County (240,200), and Madera County (141,000).

Population in the four-county area grew by 21 percent between 1990 and 2000, with Madera County growing the fastest at 40 percent, followed by Stanislaus County (21 percent), Fresno County (20 percent), and Merced County (18 percent). More recently, between 2000 and 2005, population in the study area expanded by approximately 12 percent. Madera County continued to outpace the other counties, growing 15 percent over the five-year period, followed closely by Merced County (14 percent), Stanislaus County (13 percent) and Fresno County (11 percent).

Each county contains several incorporated cities in proximity to agricultural activity in the study area. The principal incorporated cities in Fresno County proximate to the study area include Firebaugh and Mendota; in Madera County, it is Madera; in Merced County, they are Dos Palos and Los Banos; and in Stanislaus County, they are Modesto and Turlock. Population data for these cities are included in Table 1.

Table 1. Population and Population Growth in the Four-County Area (1990–2005)

County/Area	Population			Population Growth (%)	
	1990	2000	2005	1990–2000	2000–2005
Fresno County	667,490	799,407	883,537	19.8%	10.5%
Firebaugh	4,429	5,743	6,741	29.7%	17.4%
Mendota	6,821	7,890	8,739	15.7%	10.8%
Merced County	178,403	210,554	240,162	18.0%	14.1%
Dos Palos	4,196	4,581	4,854	9.2%	6.0%
Los Banos	14,519	25,869	32,380	78.2%	25.2%
Madera County	88,090	123,109	141,007	39.8%	14.5%
Madera	29,283	43,207	50,842	47.5%	17.7%
Stanislaus County	370,522	446,997	504,482	20.6%	12.9%
Modesto	164,746	188,856	207,634	14.6%	9.9%
Turlock	42,224	55,810	67,009	32.2%	20.1%
Service Area (Total)	**1,304,505**	**1,580,067**	**1,769,188**	**21.1%**	**12.0%**

Sources: California Department of Finance (Demographic Research Unit), 2002 and 2005a

Population projections through 2030[4] for counties in the study area are shown in Table 2. Regional population growth in the four-county area is projected at nearly 71 percent between 2000 and 2030, with population increasing from nearly 1.6 million in 2000 to 2.7 million in 2030 (California Department of Finance, 2004a). The rate of population growth is expected to decrease over time, with the greatest amount of growth, on a percentage basis, expected to occur between 2000 and 2010 (22.6 percent). Among counties, Merced County is projected to experience the most growth with its population more than doubling through 2030 relative to year 2000 conditions. Population growth in the other counties is expected to be more modest, ranging from 62.3 percent in Fresno County to 78.6 percent in Madera County.

Table 2. Population Projections in the Four-County Area (2000-2030)

County/Area	Population			Population Growth (%)		
	2010	2020	2030	2000-2010	2010-2020	2020-2030
Fresno	949,961	1,114,654	1,297,476	18.8%	17.3%	16.4%
Merced	277,715	360,831	437,880	31.9%	29.9%	21.4%
Madera	150,278	183,966	219,832	22.1%	22.4%	19.5%
Stanislaus	559,051	653,841	744,599	25.1%	17.0%	13.9%
Service Area (Total)	**1,937,005**	**2,313,292**	**2,699,787**	**22.6%**	**19.4%**	**16.7%**

Sources: California Department of Finance (Demographic Research Unit), 2004a

[4] Year 2030 represents the end of the approximately 25-year period through which water transfers would be made for this analysis. For example, if a transfer agreement is signed for water year 2008, it would extend until 2033.

1.1.2 Race / Ethnicity

Race (or ethnicity) is an important consideration for evaluating potential environmental justice-related effects of the Proposed Action. The racial and ethnic composition of the four-county study area is presented in Table 3. Generally, the two predominant racial groups in the study area are Whites (Caucasian) and Hispanics; together, these groups comprise roughly 87 percent of the region's population (California Department of Finance, 2005b). The relatively large proportion of Hispanics living and working in the study area is characteristic of most Central Valley counties, where agriculture supports a large Hispanic workforce. The other racial groups, combined, represent only 13 percent of the regional population. Asians account for 6.4 percent and Black/African Americans accounting for 4.0 percent, and other groups account for less than two percent of the total population.

There is little variation in the racial composition among study area counties. Stanislaus County has the highest White population at 58.4 percent and the lowest Hispanic population at 31.7 percent. Fresno County appears to be the most racially diverse county in the study area, with nearly 5.1 percent Black/African American and 8.2 percent Asian residents. The largest Hispanic population in the study area is in Merced County (45.4 percent), which is only slightly higher than Madera and Fresno counties.

Table 3. Race / Ethnicity in the Four-County Area (2003)

County/Area	Race (Percent of Total Population)						
	White	Black/ African American	American Indian/ Alaska Native	Asian	Native Hawaiian/ Pacific Islander	Multi-Race	Hispanic/ Latino
Fresno	40.4%	5.1%	0.8%	8.2%	0.1%	1.4%	44.0%
Merced	41.7%	3.6%	0.6%	7.0%	0.1%	1.6%	45.4%
Madera	47.5%	3.9%	1.4%	1.3%	0.1%	1.5%	44.3%
Stanislaus	58.4%	2.4%	0.8%	4.3%	0.4%	2.0%	31.7%
Service Area (Total) [1]	**46.3%**	**4.0%**	**0.8%**	**6.4%**	**0.2%**	**1.6%**	**40.7%**

[1] Represents an average for the study area counties, weighted by population.

Sources: California Department of Finance (Demographic Research Unit), 2005b

1.2 Economic Base

This section describes the current economic base in the study area, which may be potentially affected by the proposed water transfer under consideration. These effects could include changes in employment across a range of economic sectors and associated effects on earnings and income. The following section builds on this discussion, focusing on baseline economic conditions attributed directly to agricultural activity that is supported, in part, by water supplies delivered by the Exchange Contractors.

1.2.1 Employment and Major Industries

Data on total and industry employment provide important insights into the size, strength, and diversity of a local economy. Total employment across the four counties in the study area is presented in Table 4. In total, there were roughly 784,700 part- and full-time jobs in the study area counties in 2003, which represents an annual growth rate of approximately 3.3 percent (or nearly 25,000 jobs) since 2000 (Bureau of Economic Analysis 2003a). This growth rate is slower (on an annual basis) than that between 1990 and 2000, when total employment grew by nearly 128,000 jobs (or 20.2 percent). Overall, the largest concentration of jobs was located in Fresno County, while Madera County has the smallest job base. Between 1990 and 2000, Madera County had the largest job growth rate at over 50 percent; however, more recently (2000-2003), job growth was the highest in Merced County at 4.8 percent, with the other three counties experiencing growth rates ranging between 3 and 4 percent.

Table 4. Employment and Employment Growth in the Four-County Area (1990–2003)

County/Area	Employment (Jobs)			Employment Growth (%)	
	1990	2000	2003	1990–2000	2000–2003
Fresno	345,726	411,608	423,869	19.1%	3.0%
Merced	77,254	84,576	88,620	9.5%	4.8%
Madera	35,673	53,663	55,487	50.4%	3.4%
Stanislaus	173,179	209,914	216,748	21.2%	3.3%
Service Area (Total)	**631,832**	**759,761**	**784,724**	**20.2%**	**3.3%**

Sources: U.S. Department of Commerce (Bureau of Economic Analysis), 2003a

Employment by industry under current conditions[5] for the four-county study area is presented in Table 5. Generally, the economy in the study area is diverse. Overall, the largest sector in the study area in 2003 was Services, which employed over one-quarter million people and accounted for about one-third of the regional job base (Bureau of Economic Analysis 2003b). Other leading sectors in the regional economy include federal and state/local Government (15 percent of the total job base) and Wholesale and Retail Trade (at least 13 percent[6]). In 2003, farm employment in the study area provided over 58,000 jobs or 7.4 percent of the study area total.

At the county level, Fresno County provided the greatest number of farm jobs (roughly 27,850); however, on a proportional basis, farming in Merced and Madera counties plays a larger role, accounting for 12.5 percent and 11.9 percent of the county job totals, respectively. Within parts of the Exchange Contractors service area, the figures are substantially higher because of the agricultural concentration of those subregions. Indirectly, farming and agriculture also provide numerous jobs in those industries that supply inputs to agricultural operations (e.g., farm machinery and fertilizers) and industries that are reliant on agricultural commodities (e.g., food processing plants); these economic linkages are discussed in greater detail below.

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[5] Comparisons between 2003 NAICS data and 2000 and earlier SIC data are not feasible based on different industry groupings; therefore, historical trends at the industry level are not presented.

[6] This figure could be higher based on undisclosed data at the county level – see Table 5.

Table 5. Employment by Industry in the Four-County Area (2003)

Industry/Sector [1]	Jobs (by County) [2]				Total [3]	Percent of Total
	Fresno	**Merced**	**Madera**	**Stanislaus**		
Farm / Agriculture	27,854	11,104	6,630	12,489	58,077	7.4%
Natural Resources and Mining	36,693	4,847	(D)	8,672	*<50,212>*	*<6.4%>*
Construction	22,908	4,218	3,260	14,258	44,644	5.7%
Manufacturing	28,604	11,016	3,741	22,085	65,446	8.3%
Wholesale and Retail Trade	58,724	(D)	5,742	34,952	*<99,418>*	*<12.7%>*
Transportation, Warehousing, and Utilities	12,879	(D)	1,304	6,639	*<20,822>*	*<2.7%>*
Finance and Insurance	15,377	1,712	1,090	6,359	24,538	3.1%
Services	153,803	26,843	(D)	83,537	*<264,183>*	*<33.7%>*
Federal Government	11,659	1,229	577	2,094	15,559	2.0%
State/Local Government	55,368	12,972	8,688	25,393	102,421	13.1%
Total	**423,869**	**88,620**	**55,487**	**216,748**	**784,724**	**100%**

[1] Industry/sectors based on a summary of NAICS industry classifications

[2] (D) = Estimate not available to avoid disclosure of confidential information. Values included in county totals.

[3] Italicized numbers in brackets represent partial totals based on available data at the county level and excludes values that were not available due to disclosure issues (see footnote 2). Missing data are included in the totals.

Sources: U.S. Department of Commerce (Bureau of Economic Analysis), 2003b

Based on differences in industry groupings between NAICS (2002 and later) and SIC (pre-2002), it is difficult to report recent employment trends across industries. However, employment trends between 1990 and 2000 provide valuable insight into the evolving economy in the four-county study area. Between 1990 and 2000, the percentage of employment in agriculture and agricultural services has risen, as has employment in other services (Bureau of Reclamation 2004). During this same period, the percentages of jobs in construction and mining, manufacturing, trade, and government have fallen. The increase in agricultural services is primarily in professional farm managers, custom operators, and labor contractors.

1.2.1.1 Unemployment

Local unemployment figures are a common indicator of social and economic well-being within a community. Information on the size of the labor force and average annual unemployment rates in the study area since 1990 is presented in Table 6. Unemployment in the study area has fluctuated since 1990, falling from 12 percent in 1990 to 9.6 percent in 2000 and subsequently rising to 10 percent in 2004 (California Employment Development Department, 2005). These historical patterns in the study area hold across individual counties and the State; however, regional unemployment has been substantially higher than statewide averages. For example, the unemployment rate in the study area in 2004 was 10 percent compared to only 6.7 percent statewide; such differences were even greater in previous periods. In 2004, Merced County had the highest unemployment rate of the four counties at 10.8 percent, while unemployment was lowest in Madera County at 8.8 percent.

Table 6. Unemployment in the Four-County Area (1990-2004) [1]

County/Area	1990 Labor Force	1990 Unemp. Rate	2000 Labor Force	2000 Unemp. Rate	2004 Labor Force	2004 Unemp. Rate
Fresno	328,900	11.7%	389,200	10.4%	409,500	10.4%
Merced	76,900	12.9%	90,500	9.6%	98,900	10.8%
Madera	41,600	13.5%	55,100	8.7%	63200	8.8%
Stanislaus	180,500	11.9%	208,100	8.3%	226,100	9.1%
Service Area (Total) [2]	627,900	12.0%	742,900	9.6%	797,700	10.0%

[1] Annual unemployment rates are based on non-seasonally adjusted monthly unemployment data.

[2] Unemployment rates represent an average for the study area counties, weighted by population.

Sources: California Employment Development Department, 2005

1.2.2 Income

Total personal income[7] levels across counties and in the study between 1990 and 2003[8] are presented in Table 7. Total personal income in the four-county study area in 2003 was $40.2 billion (Bureau of Economic Analysis, 2003a). In real terms, total income in the study area counties has increased by more than 30 percent between 1990 and 2003. The rate of income growth has been more pronounced in recent years (2000 to 2003) than in the previous decade. Of the study area counties, Fresno County had the highest personal income in 2003 ($20.7 billion) and Madera County had the lowest ($2.7 billion). Madera County, however, has outpaced the other counties in income growth since 2000 at 12.6 percent, followed closely by Merced County at 11.9 percent. After realizing a nearly 28 percent rate of income growth between 1990 and 2000, Stanislaus County has experienced the lowest rate of income growth since 2000 at 5.5 percent. Among the 58 counties in the State, personal income in Fresno County in 2002 was the 13th largest, Stanislaus was 21st, Merced was 30th, and Madera was 35th (California Department of Finance, 2004b).

[7] Personal income is defined as the income that is received by persons from participating in production, from both government and business transfer payments, and from government interest (which is treated like a transfer payment). It is calculated as the sum of wage and salary disbursements, other labor income, proprietors' income with inventory valuation and capital consumption adjustments, rental income of persons with capital consumption adjustment, personal dividend and interest income, and transfer payments to persons, less personal contributions for social insurance (Bureau of Economic Analysis, 2005).

[8] Similar to employment, historical trends in total income are presented at the county and study area level, while information on income by economic sector is presented for current (2003) conditions only.

Table 7. Total Personal Income and Income Growth in the Four-County Area (1990–2003) [1,2]

County/Area	Income ($000)			Income Growth (%)	
	1990	2000	2003	1990–2000	2000–2003
Fresno	$15,888,137	$18,835,603	$20,651,377	18.6%	9.6%
Merced	$3,844,762	$4,417,134	$4,943,734	14.9%	11.9%
Madera	$1,868,274	$2,420,320	$2,725,002	29.5%	12.6%
Stanislaus	$8,845,930	$11,297,129	$11,919,892	27.7%	5.5%
Service Area (Total)	**$30,447,104**	**$36,970,186**	**$40,240,005**	**21.4%**	**8.8%**

[1] Values in thousands ($1,000) of dollars.

[2] Values presented in the tables are in constant 2003 dollars (adjusted based on Consumer Price Index).

Sources: U.S. Department of Commerce (Bureau of Economic Analysis), 2003a

Table 8 presents earnings by industry (a component of total personal income) in the study area in 2003. The measure of earnings by industry is more relevant than total personal income for evaluating the potential impacts of the Proposed Action on the local economy because it focuses on wages/salaries of employees and proprietor's (or business) income. In addition, it excludes other factors such as transfer payments which are unlikely to be affected by the project. Following patterns similar to employment, the Services sector had the highest level of earnings with at least $8.4 billion[9], which accounted for over 30 percent of all earnings in the study area (Bureau of Economic Analysis, 2003c). Other sectors that provide a relatively high proportion of employment earnings in the study area include federal and state/local Government (20 percent), Wholesale and Retail Trade (at least 11.5 percent), and Manufacturing (11.3 percent). Farm-related earnings account for 5.1 percent of the study area total.

Table 8. Earnings by Industry in the Four-County Area (2003)[1]

Industry/Sector [2]	Personal Income (by County) [3]				Total [4]	Percent of Total
	Fresno	Merced	Madera	Stanislaus		
Farm / Agriculture	$556,748	$440,459	$131,928	$314,234	$1,443,369	5.1%
Natural Resources and Mining	$781,406	$127,866	(D)	$163,756	*<$1,073,028>*	*<3.8%>*
Construction	$1,122,224	$211,718	$185,487	$687,991	$2,207,420	7.8%
Manufacturing	$1,385,095	$436,319	$174,794	$1,212,228	$3,208,436	11.3%
Wholesale and Retail Trade	$1,907,112	(D)	$214,171	$1,150,452	*<$3,271,735>*	*<11.5%>*
Transportation, Warehousing, and Utilities	$591,165	(D)	$44,148	$314,416	*<$949,729>*	*<3.3%>*

[9] This figure could be higher based on undisclosed data at the county level – see Table 8.

Table 8. Earnings by Industry in the Four-County Area (2003)[1]

Industry/Sector [2]	Personal Income (by County) [3]				Total [4]	Percent of Total
	Fresno	Merced	Madera	Stanislaus		
Finance and Insurance	$656,932	$62,261	$23,959	$265,892	$1,009,044	3.6%
Services	$5,142,309	$711,442	(D)	$2,540,573	*<$8,394,324>*	*<29.6%>*
Federal Government	$668,449	$70,977	$30,111	$98,900	$868,437	3.1%
State/Local Government	$2,607,285	$554,416	$366,256	$1,268,781	$4,796,738	16.9%
Total	**$15,418,725**	**$3,135,716**	**$1,793,252**	**$8,017,223**	**$28,364,916**	**100%**

[1] Values in thousands ($1,000) of dollars
[2] Industry/sectors based on a summary of NAICS industry classifications
[3/] (D) = Estimate not available to avoid disclosure of confidential information. Values included in county totals.
[4] Italicized numbers in brackets represent partial totals based on available data at the county level and excludes values that were not available due to disclosure issues (see footnote 3). Missing data are included in the totals.

Sources: U.S. Department of Commerce (Bureau of Economic Analysis), 2003c

Earnings by place of work across counties in 2003 were the highest in Fresno County ($15.4 billion), followed by Stanislaus County ($8.0 billion), Merced County ($3.1 billion), and Madera County ($1.8 billion). However, farm earnings in Madera County account for a significantly higher percentage of total earnings at 14 percent compared to 3.7 to 7.4 percent in the other three counties.

1.2.2.1 Income-Related Measures of Social Well-Being

As derivatives of total personal income, per-capita and median household income and poverty rates represent other economic indicators of social well-being. These three measures are discussed below.

In 2002, per-capita personal income in the four-county study area (on a weighted average basis) was $22,841. Across counties, per-capita income levels were $23,492 in Fresno County, $20,623 in Merced County, $19,617 in Madera County, and $23,642 in Stanislaus County (California Department of Finance, 2004b). Per-capita income for the State averaged $32,989 in 2002. Based on these figures, per capita personal income in Fresno, Merced, Madera and Stanislaus counties ranked 45th, 51st, 55th, and 32nd in the State, respectively.

Based on 2000 Census data (1999 dollars), the weighted average median household income in the study area was $36,493, which is about 30 percent lower than the statewide figure of $47,493. Median household income at the county level was highest in Stanislaus County ($40,101), followed by Madera County ($36,286), Merced County ($35,532), and Fresno County ($34,725) (California Department of Finance, 2004b).

Poverty rates represent the percentage of an area's total population living at or below the poverty threshold established by the U.S. Census Bureau[10.] Based on 2000 Census data (1999 income data), the weighted poverty rate in the study area is 15.9 percent, which is considerably higher than the statewide rate of 10.6 percent. The poverty rate in individual counties is highest in

[10] Poverty thresholds used by the U.S. Census Bureau vary and are based on a range of factors, including money income, size of family, and age of family members.

Fresno County (17.6 percent), followed by Merced County (16.9 percent), Madera County ($15.9 percent), and Stanislaus County (12.3 percent) (California Department of Finance, 2004b).

1.3 Agricultural Production and Values

Agriculture is one of the primary economic sectors within the Exchange Contractors service area and has been so for over a century. Agriculture is important in providing crops for final consumption in the local area and other national and international markets; supporting the local dairy and food processing industries; and for generating overall local economic activity. Existing agricultural production and values,[11] as well as the regional economic activity generated from agriculture, are presented below. Information is presented for three areas: (1) the four-county area within which the Exchange Contractors service area is located; (2) the Exchange Contractors service area itself; and (3) the 28,000-acre area that is subject to high groundwater levels.

1.3.1 Agriculture in the Four-County Area

Current cropping patterns and related agricultural production values in the four-county study area are presented in Table 9. There were over 2.5 million acres of land in crop production in the four-county area in 2004. The majority of crop production (52.1 percent) was in field crops. The individual shares of fruit, nut, and vegetable crops ranged between 13 and 18 percent each of total acreage. Seed and nursery crops accounted for less than one percent of the total. In terms of production value, however, field crops, which represented over half of the production acreage, only accounted for about 16 percent of production value. Fruits, nuts and vegetables had the highest values, each between $1.5 billion and $1.7 billion (in 2004 dollars); together, these three crop groups accounted for over 81 percent of the total production value in the four county area, which stood at nearly $6.1 billion in 2004. The average production value in the four-county area was $2,395 per acre.

Table 9. Crop Acreage and Value in the Four-County Exchange Contractors Area, 2004

Crop Group	Acres	Percent of Total Acres	Value ($000)	Percent of Total Value	Value per Acre
Field crops	1,318,872	52.1%	$980,578	16.2%	$744
Fruits	454,383	18.0%	$1,693,201	27.9%	$3,726
Nursery crops	720	0.0%	$64,835	1.1%	$90,049
Nuts	399,640	15.8%	$1,673,888	27.6%	$4,188
Seed crops	23,428	0.9%	$92,464	1.5%	$3,947
Vegetables	333,005	13.2%	$1,553,502	25.6%	$4,665
Total	2,530,048	100.0%	$6,058,468	100.0%	$2,395

Source: California Agricultural Statistics Service, 2005 (2004 County Agricultural Commissioners' Data), ENTRIX, 2007

[11] Agricultural values represent the farm gate values of cultivated products, which is the net value of the product when it leaves the farm.

1.3.2 Agriculture within the Exchange Contractors Service Area

The primary crops grown within the Exchange Contractors service area are cotton, melons, alfalfa hay, grains, vegetables, field crops, fruits and nuts (orchards) and grapes (vineyards). All crops are irrigated because of the limited rainfall characterizing the entire San Joaquin Valley. The service area is large, no single crop is dominant, and agricultural production is diversified. Within certain subareas, some crops are more common than others because of climate, water, and soil variations.

Over time, agriculture in the service area has evolved to intensively-farmed crops and away from land-extensive livestock and grain production. Moreover, a comprehensive infrastructure of businesses has developed in support of production agriculture. These include suppliers of inputs such as feed, seed, chemicals, irrigation equipment, and farm machinery; food processors and cotton gins; financial institutions; transportation and shipping companies; and storage businesses. They also include food processors, shippers, and other businesses which use products after they leave farms. Each of these sectors purchases from and sells to many other businesses, and consequently, changes in agriculture have widespread ripple effects throughout the regional economy; these effects are described in more detail below.

Within the service area, the average total amount of land in agricultural crop production under existing conditions is approximately 231,500 acres[12] (Table 10). The largest amount of acreage is in cotton (nearly 30 percent), followed by alfalfa hay and seed, miscellaneous field crops, grains, vegetables, and permanent crops. The total annual value of crops grown in the Exchange Contractors service area under current conditions (and based on 2004 production values) is estimated at $330.3 million. The acres and per acre values of crops grown in the service area vary substantially. For example, vegetables account for 7.9 percent of acreage, but 23.2 percent of value. Similarly, fruits, nuts, trees and vines account for 4.3 percent of land in production, but 10.9 percent of value. On the other hand, grains account for 8.8 percent of acreage, but only 2.7 percent of total value. The differences have important implications for the regional economic impacts of producing various crops, as discussed below.

The cropping patterns within the Exchange Contractors service area differ importantly from the patterns for the total four-county area within which the Exchange Contractors area is located. For example, permanent crops account for 4.3 percent of acreage within the Exchange Contractors area and 33.8 percent in the total four-county area. In addition, field crops account for 82.2 percent of Exchange Contractors service area land and 52.1 percent of the four-county area. Cropping patterns for vegetables are more similar with vegetables (including melons) accounting for 10.7 percent of service area land and 13.2 percent of the four-county area.

Cropping patterns in the Exchange Contractors service area have changed over time. Some of the factors accounting for changes include crop prices and supplies, changes in consumer demands, surface water availability, and the development of crop varieties suitable for different soil and climate conditions. Low prices accounted for much of the decline in cotton acreage in the mid-to-late 1990s.

[12] The data represent average acreage for 2000-2004 to smooth out normal annual variations due to crop rotations and other influences.

Table 10. Average Cropping Patterns and Values in the Exchange Contractors Service Area [1,2]

Crop Group	Acres	Percent of Total Acres	Value ($000)	Percent of Total Value	Value per Acre
Alfalfa hay and seed	59,527	25.7%	$55,603	16.8%	$934
Cotton	69,049	29.8%	$92,724	28.1%	$1,343
Other field crops	33,290	14.4%	$29,686	9.0%	$892
Fruits, nuts, trees, vines	10,041	4.3%	$35,921	10.9%	$3,578
Melons	6,551	2.8%	$29,513	8.9%	$4,505
Vegetables	18,228	7.9%	$76,735	23.2%	$4,210
Grains	20,361	8.8%	$8,669	2.6%	$426
Pasture/hay/forage	8,148	3.5%	$1,420	0.4%	$174
Fallow	6,327	2.7%	$0 [3]	0.0%	$0
Total [4]	**231,522**	**100.0%**	**$330,271**	**100.0%**	**$1,427**

[1] Based on average acreages between 2000 and 2004.
[2] Agricultural values calculated using 2004 values per acre in the four-county region.
[3] Does not include value of crops in other areas to which water from fallowed land is applied.
[4] Excludes acreage/value attributed to ponds/ducks.

Source: Exchange Contractors, 2005; California Agricultural Statistics Service, 2005 (2004 County Agricultural Commissioners' Data); ENTRIX, 2007

1.3.3 Agriculture in the Affected 28,000 Acre Area

Approximately 28,000 acres of land in Exchange Contractors service area are affected by high groundwater tables. A potential benefit of the project is that groundwater pumping under two of the three action alternatives would lower the groundwater level in this area. The affected area is located primarily in the FCWD and the Camp 13 area of CCID. Cropping patterns in FCWD were used to approximate crop production for the entire 28,000 acre area. These data are presented in Table 11.

Of the affected 28,000 acres, it is estimated that 43 percent (or nearly 12,000 acres) are planted in cotton. Other significant acreages include alfalfa and hay seed, vegetables, and melons, each of which accounts for more than 10 percent of total crop acreage. In terms of value, the leading crop group is vegetables, followed by cotton and melons; these three groups account for 32.9 percent, 28.9 percent, and 23.1 percent of total production value, respectively. Total crop production is estimated at $55.6 million. On a per-acre basis, vegetables are the most valuable commodity with a production value of almost $6,400 per acre.[13]

Table 11. Average Cropping Patterns and Values in the Affected 28,000 Area [1,2]

Crop Group	Acres	Percent of Total Acres	Value ($000)	Percent of Total Value	Value per Acre
Alfalfa hay and seed	5,004	17.9%	$4,669	8.4%	$933

[13] As noted in the footnotes to Tables 10 and 11, this excludes the value attributable to land on which water from the fallowed land may be applied in other areas.

Cotton	11,955	42.7%	$16,054	28.9%	$1,343
Other field crops	1,557	5.6%	$2,384	4.3%	$1,531
Fruits, nuts, trees, vines	97	0.3%	$223	0.4%	$2,297
Melons	2,845	10.2%	$12,817	23.1%	$4,505
Vegetables	2,867	10.2%	$18,274	32.9%	$6,373
Grains	2,744	9.8%	$1,099	2.0%	$399
Pasture/hay/forage	360	1.3%	$87	0.2%	$240
Fallow	570	2.0%	$0 [3]	0.0%	$0
Total	**28,000**	**100.0%**	**$55,602**	**100.0%**	**$1,986**

[1] Based on average acreages of crops grown between 2000 and 2004 in FCWD, which are representative of the affected 28,000 acre area. FCWD data were extrapolated to the 28,000 acre area based on average cropping patterns.
[2] Agricultural values calculated using 2004 values per acre in the four-county region. Assumes that crop yields in the four-county region are representative of yields in the affected 28,000 acre area.
[3] Does not include value of crops in other areas to which water from fallowed land is applied.

Source: San Joaquin Exchange Contractors, 2005; California Agricultural Statistics Service, 2005 (2004 County Agricultural Commissioners' Data); ENTRIX, 2007

1.3.4 Regional Economic Effects of Existing Agricultural Production

As discussed previously, any change in agricultural production sets in motion a series of "ripple effects," which collectively cause changes in output, employment, and income throughout the regional economy. These linkages are frequently quantified by the use of input-output (I-O) models, which are discussed in Attachment A. Table 12 presents the regional economic impacts of current agricultural production in the four-county study area, the Exchange Contractors service area, and the affected 28,000 acre area.

Table 12. Regional Economic Impacts – Existing Agricultural Production (2004) [1,2]

Area of Agricultural Production	Output ($ Million)		Labor Income ($ Million)		Employment (Jobs)	
	Direct	Total	Direct	Total	Direct	Total
Four-County Area	$6,058.5	$9,828.5	$1,387.8	$3,002.6	57,698	118,064
Exchange Contractor Service Area	$330.3	$538.2	$65.2	$153.2	3,198	6,507
28,000 Acre Area	$55.6	$89.6	$11.4	$25.8	503	1,043

[1] Based on IMPLAN modeling for the four-county study area.
[2] Values reported in 2004 dollars.

Source: ENTRIX, 2007

In the four-county area, the direct output (or value) of agricultural crop production was over $6 billion in 2004. This level of production indirectly generated an additional $3.8 billion in output value for a total of over $9.8 billion in the four-county area. The direct labor income generated by this level of production was nearly $1.4 billion, and over $3 billion in total. The direct and total employment effects of existing agricultural production in the four-county area were approximately 57,700 and 118,000 jobs, respectively.

The regional economic effects attributable to crop production in the Exchange Contractor service area and the 28,000 acre area are also substantial. Crop production in the Exchange Contractor service area resulted in $330.3 million and $538.2 million in direct and total output, $65.2

million and $153.2 million in direct and total labor income, and 3,198 and 6,507 direct and total jobs, respectively. In the 28,000 acre area, roughly $55.6 million and $89.6 million in direct and total output were generated by crop production, respectively, which resulted in $11.4 million and $25.8 million in direct and total labor income, and 503 and 1,043 direct and total jobs, respectively.

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2.0 ENVIRONMENTAL CONSEQUENCES

This section describes the environmental consequences of the alternatives considered for this project. It includes estimated economic impacts for each alternative over the 25-year project timeframe. The alternatives analyzed are the No Action/No Project (No Action) Alternative, Proposed Action, an Alternative Action including only groundwater pumping, and an Alternative Action excluding groundwater pumping but including conservation measures and land fallowing.

The actions incorporated in the alternatives will affect production, consumption, and investment decisions in agriculture and related industries. As a result, the final demand for the goods and services produced in these sectors will change. The changes in final demands are utilized to compute direct impacts, measured as changes in output, employment and income primarily in the agricultural sector. Other sectors will also be directly affected, including various water-related industries that would be called upon to implement a range of conservation and drainage reduction projects. In addition, changes in final demands will produce indirect and induced impacts in agriculture and many other sectors of the regional economy because of the linkages and interdependencies among industries (U.S. Bureau of Reclamation, 1997).

In this section, the direct, indirect, and total (or regional) economic impacts of the various alternatives are presented. For each alternative, the direct economic impacts attributed to agriculture and related agricultural activities are presented first. Related activities include investment in water conservation and drainage reduction projects, payments to farmers for land fallowing, and the avoided costs of water treatment. Subsequently, the regional economic impacts associated with each alternative are presented based on the results generated by a county-level I-O model.

For the No Action Alternative, the environmental consequences are based on expected physical changes and related economic implications attributed to agricultural production at the end of the project timeframe relative to existing conditions (as presented in the Environmental Setting section). For this analysis, the No Action Alternative reflects a scenario of predictable future changes which may occur, based on other approved plans and projects, and which excludes any Action Alternatives being considered herein. For each Action Alternative, the environmental consequences are based on future conditions under the alternatives relative to No Action Alternative.

In the following discussion, an assessment is made regarding the significance of changes in different variables. There were no convenient yardsticks to assess the significance of changes noted in any of the variables or issues analyzed. It was not possible to perform statistical tests of significance on such variables as percentages of acres in various crops, since information on individual landholdings was not available. It was therefore decided on the basis of professional judgment that any change of five percent or greater in the annual value of farm production or regional economic variables (i.e., total output, income, and employment) is significant.

2.1 No Action/No Project Alternative

The No Action Alternative is the “baseline” or benchmark of future conditions for comparison of the impacts of the Proposed and Alternative Actions. Under No Action, there would be no additional groundwater pumping, water conservation measures, or land fallowing within FCWD and Camp 13, and therefore, no transfer of water to other CVP water users. It assumes reasonably-foreseeable events regarding drainage water and other variables including, but not limited to:

1. Continued influence on irrigated agriculture by market forces, which in turn affect irrigation demands.
2. No additional land fallowing beyond that which is part of the existing Exchange Contractors transfer program and which is part of normal cropping practices.
3. Continued influence of hydrologic and climate conditions on irrigated agriculture in the area.
4. Farmers are price takers, without adequate market share to control market prices.
5. Changes in the costs of farm management and farm inputs such as water, fertilizers, seed, and labor have a direct effect on profitability. Increased costs for water, disposing of water, or managing land more intensely thus lowering profit, other factors unchanged.
6. Farmers make cropping and management decisions on the basis of which options offer the greatest possible profit for their enterprises.

For the No Action Alternative discussion herein, it has been noted previously that the 28,000 acre area within FCWD and the Camp 13 part of CCID is affected by shallow groundwater levels which extend to the crop root zone. Currently, water captured in the area by drainage systems is diverted through Grassland Bypass to the San Luis Drain and ultimately to Mud Slough. However, after December 31, 2009, the Grassland Bypass and San Luis Drain will no longer be available for disposal of drain water from the 28,000 acres and other areas. All drain water will then need to be recycled and reused in the area. Consequently, the quality of shallow groundwater will deteriorate and severely affect the yields of the crops planted in the area. As discussed below, land will likely go out of production quickly once drainage through the Grassland Bypass Project's Use Agreement has expired.[14]

A similar sequence of events was reported separately for the Grassland Bypass Project (U. S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority, 2001). For the No Action Alternative in that analysis, it was assumed that all agricultural drain water would be recirculated onto cropland for reuse after 2009. Soil salinity increased from 1.0 millimhos per centimeter (mmhos/cm) to 6.2 mmhos/cm over a 10 year period. All crop yields, other than cotton, fell. Melons and fresh and processing tomatoes all fell by the tenth year to 63 percent of their respective beginning yields. After 10 years, beans, the most salt-sensitive crop in the area, could no longer be grown.

More severe impacts can be expected in the 28,000 acre study area under the No Action Alternative. Drainwater in the 28,000 acre area is not only from irrigation of that area, but also from upslope lands. Thus, under the No Action Alternative, the land can be expected to be permanently fallowed even more quickly than that in the Grassland Bypass area.

The Bureau of Reclamation (2002) notes several considerations for the drainage-impacted areas of the San Luis Unit which are also pertinent for FCWD and Camp 13 study area:

- Unless irrigation is limited to hold deep percolation equal to natural drainage, salts will continue to accumulate in shallow groundwater and will also continue to migrate to deeper groundwater over time.

[14] It is possible that the Grassland Bypass Project may be extended past 20009, but no extension has been evaluated or scoped yet with the public.

- Intense irrigation management is required, entailing both high seasonal application efficiency and high distribution uniformity. The costs for management and irrigation hardware are significantly higher than for irrigation under well-drained conditions.
- If higher irrigation and management costs cannot be supported by crop revenues, the land will go out of production.
- Relatively small changes in the water and salt balance, e.g. due to reduced groundwater pumping which historically provided some part of natural drainage, may result in rapid worsening of root zone conditions.
- Crops generally need to be restricted to low-evapotranspiration products such as small grains and wheat. Sugar beets and some forage crops are relatively salt tolerant, but require large amounts of water.

The Bureau of Reclamation (2005c) also notes that future discharge load limits and requirements to comply with water quality objectives will make it infeasible, if not impossible, to continue significant drainage discharges in the San Luis Unit. Such an assumption seems equally valid for the 28,000 acre study area. Farmers will be forced to expend much more management time on this land and/or change to crops which require less water. In both cases, production costs relative to crop value will increase. In a study of the proposed drainage of the San Luis Unit, the Bureau of Reclamation (2002) found that increased irrigation and salinity management costs in the drainage impacted lands of Westlands Water District were about $90 per acre of farmland. For many of the crops grown in the 28,000 acre area, a cost increase of that magnitude would reduce significantly or eliminate the profitability of growing those crops.

Given the cropping mix in the 28,000 acre area, as groundwater becomes shallower under the No Action Alternative, salt levels would increase in crop root zones and crop yields would be expected to decline. At some point, farming would no longer be profitable, and farmers would idle their land. For purposes of the analysis, it is assumed that salinity would build up quite rapidly in the area as drain water is recycled, leading to reduced yields and land idling. Given the trends noted before for the Grassland Drainage Area over 10 years, it is assumed that all of the 28,000 acres would be retired in 25 years (by the end of the project timeframe).[15]

The economic effects of retiring 28,000 acres from agricultural production are straightforward. With no crop production, there would be no agricultural production value or direct economic activity generated by agriculture in the affected 28,000-acre area. In addition, there would be no project-related expenditures made on conservation projects, payments to farmers, or changes in water treatment costs; as a result, no indirect economic impacts would occur in the region. In summary, the No Action Alternative would not generate any direct or indirect economic activity in the four-county study area that is attributed to agricultural activity in the affected 28,000-acre area.

Relative to existing conditions, the direct annual losses would include $55.6 million in agricultural output and $11.4 million in labor income (in 2004 dollars), along with 503 jobs. Economic losses to the region would total $89.6 million in annual economic output, $25.8

[15] In the Westlands Water District, much of a 43,000 acre area for which drainage service was terminated went out of production within five years because of the buildup of salinity in the root zone (Ken Swanson, Boyle Engineering, December 15, 2005, personal communication). Also, as noted in the Grassland report (p. G-28), if the analysis were period had been extended beyond ten years, land would be removed from production.

million in annual income, and 1,043 jobs. A comparative summary of the total economic effects of the project alternatives relative to existing conditions is presented in Table 21.

2.2 Proposed Action

Under the Proposed Action, up to 20,000 AFY (AFY) of substitute water would replace an equal amount of DMC water that would then be sold to other CVP contractors in the San Luis and/or San Felipe Units. Maximum groundwater pumping would be 15,000 AFY from 15 new and 5 existing wells. The remaining 5,000 AFY would be from conservation and rotational land fallowing.[16] CVP San Luis Unit agriculture service contractors could receive up to 20,000 AFY. Local CVP M&I transfers could include up to 2,000 AFY in SCWVD and up to 5,000 AFY in SLWD. Some of the direct impacts of the Proposed Action would include the following:

- Continued agricultural production on lands that are not fallowed.
- Payments to farmers for fallowed land.
- Reduced output of water from tile drains to be treated.
- Revenues to the Exchange Contractors from purchasers of DMC water.
- Expenditure of funds received by Exchange Contractors for the capital cost of wells, pumps, and infrastructure needed to pump groundwater and convey it to the CCID service area for mixing with DMC water before being applied to cropland in CCID.
- Expenditures of funds received by the Exchange Contractors for various conservation and drainage reduction projects and infrastructure.
- Expenditures of funds by the Exchange Contractors for operations and maintenance (O&M) activity to support new wells, pumps, facilities, and infrastructure.
- Outlays for pumping groundwater from new and existing district wells.
- Reduced flows of poor-quality groundwater to Madera County.
- Regional economic effects associated with direct effects described above.

2.2.1 Continued Agricultural Production

Based on an average value of 2.75 AF of irrigation water required per acre, it is estimated that up to approximately 1,818 acres of farmland would be fallowed under the Proposed Action (under the worse-case scenario). The land fallowed would be rotated among the 28,000 acres such that the same land would not be fallowed consecutively for more than one year. The remaining 26,182 acres in the affected 28,000-acre area would remain in agricultural production. It is assumed that the same cropping patterns would be maintained in this area and crop prices would be similar to existing conditions. It is also assumed that there would be no change in crop yields (on a per-acre basis) based on reductions in water application (due to fallowing) and conservation projects that would limit water entering the groundwater table. The value of reduced crop output associated with land fallowing is estimated to be almost $3.1 million per year, which is input into the I-O model as a reduction in final demand for the crops fallowed. Representative data that are used as inputs in the I-O modeling are shown in Table 13.

[16] For the economic analysis, substitute water from non-groundwater sources (5,000 AFY) are assumed to come from land fallowing so that the analysis represents worse-case economic conditions.

Table 13. Fallowed Land Acreage, Gross Value, and Net Income in the Affected 28,000-Acre Area: Proposed Action

Crop	Acres		Per Acre		Fallowed Acre Totals	
	Total	Fallowed	Gross Value [1]	Net Profit [2]	Gross Value	Net Profit
Cotton	11,955	1,098	$1,343	$422	$1,474,000	$462,900
Alfalfa	5,004	459	$933	-$72	$428,600	-$33,000
Melons	2,845	261	$4,505	-$114	$1,176,700	-$29,800
Total	19,804	1,818	--	$220.09 [3]	$3,079,400	$400,200

[1] Based on 2004 agricultural commissioner reports for the four-county area as presented by the California Agricultural Statistics Service (2004).
[2] Based on crop yields and prices reported in CASS (2004) and various crop budgets produced by the University of California Cooperative Extension. For cotton, see UC Extension, 2003a. For alfalfa, see UC Extension, 2003b. For melons, see UC Extension, 2004.
[3] Represents weighted average across crop groups in 2004 dollars.

Source: California Agriculture Statistics Service (CASS), 2004; ENTRIX, 2007

2.2.2 Payments to Farmers

It is assumed that farmers would fallow their land voluntarily and that they would be paid a sum that is equivalent to the average net profit they receive per acre for the crops grown on the land; this value is estimated at about $220 per acre per year (2004 dollars). If it assumed that farmers fallow sufficient land to provide 5,000 AFY (or 1,818 acres), total payments to farmers are estimated to be about $400,200 annually over the life of the project (see Table 13). For this analysis, net profit per acre was calculated by weighting the average net profit per acre for cotton, alfalfa, and melons in the region by their respective acreages within the 28,000 acre area. Regional estimated net profit values were obtained from crop production budgets published by the University of California Cooperative Extension (2003a, 2003b, and 2004). Yields per acre in the study area are assumed to be the same as those provided in the agricultural commissioner reports for Fresno County.[17]

It is uncertain how farmers will utilize the payments they are assumed to receive for fallowing. However, it is reasonable to assume that at least part of those funds will be reinvested in the farming enterprise. It is assumed the payments for fallowing are divided equally between outlays for farm machinery and equipment (50 percent) and household consumption (50 percent).

2.2.3 Reduced Output of Water from Tile Drains to be Treated

Treatment of drain water output from the tile systems underlying part of the 28,000-acre area costs an average of $1,200 per AF.[18] For groundwater pumpage of 15,000 AFY, the reduction in drain flows is estimated to be approximately 101 AFY.[19] The avoided costs from reduced drain

[17] Crop yields in the 28,000 acre area are believed to be consistent with those in other parts of Fresno County contingent upon adequate drainage of water from the crop root zone. Jeff Bryant, Manager, Firebaugh Canal Water District, December 20, 2005, personal communication.

[18] Steve Chedester, SJRECWA, December 19, 2005, personal communication.

[19] Ken Schmidt, November 2005, “Groundwater Conditions in the Firebaugh Canal Water District and CCID Camp 13 Drainage District,” Draft Report, p. 30; and personal communication June 22, 2007.

water would thus be $121,500 per year. This represents a redistribution of money from the water treatment sector of the regional economy to farmer income. It is uncertain how farmers would utilize increases in income; however, it is reasonable to assume that at least part of those funds will be reinvested in the farming enterprise. It is assumed increases in farmer incomes are spent equally between outlays for farm machinery and equipment (50 percent) and household consumption (50 percent).

2.2.4 Funds Received from Purchasers of Exchange Contractors Water

It is estimated that the purchasers of DMC water in the San Luis and/or San Felipe units would pay a lump-sum payment to the Exchange Contractors under this program. It is assumed that this payment corresponds to the capital costs of improvement and projects in the FCWD/Camp 13 area as provided by the Exchange Contractors; this lump-sum figure is estimated to be approximately $28.9 million. Assuming a 25-year program and a 3.5 percent interest rate, the equivalent uniform annual payment the Exchange Contractors would receive for the water is almost $1.8 million, or approximately $88 per AF (not adjusted for inflation).

2.2.5 Expenditure of Funds Received by Exchange Contractors

As noted above, the funds received by the Exchange Contractors under this project would be used to purchase new wells and pumps to extract groundwater and payments to farmers for land fallowing. The remaining funds would also be used for canal lining, irrigation system improvements, construction of facilities to treat drain water, and for a portion of the management and treatment identified in the Westside Regional Drainage Plan. It is assumed that the entire adjusted annualized capital cost of the project (or nearly $1.8 million) would be spent on an annual basis over the life of the project. These expenditure data, excluding payments to farmers but including annualized O&M costs discussed below, are shown in Table 14. Under the Proposed Action, the annualized value of capital expenditures and annual O&M costs are estimated to be nearly $1.4 million and $1.6 million, respectively. Total annual capital and O&M costs are estimated at almost $3.0 million.

Table 14. Conservation Program – Total and Annual Capital and O&M Costs: Proposed Action [1]

Program	Capital Costs		Annual O&M Costs	Total Annual Costs
	Total	Annual		
Irrigation Systems	$710,600	$43,100	$0	$43,100
Lining Facilities	$2,153,300	$130,700	$0	$130,700
Pumping/Conveyance	$12,244,900	$742,900	$816,300	$1,559,300
Drainage Treatment	$7,173,500	$435,000	$800,000	$1,235,000
Total	$22,282,300	$1,351,700	$1,616,300	$2,968,000

[1] Values reported in 2004 dollars.

Source: Exchange Contractors, 2005; ENTRIX, 2007

2.2.6 O&M Expenditures and Outlays for Pumping Groundwater

Substantial O&M expenditures would be made by the Exchange Contractors to maintain the capital equipment purchased and facilities developed with the funds received for the water transfer. As shown in Table 14, it is estimated that the annual O&M costs would total approximately $1.6 million annually.

It has been estimated that the cost to pump groundwater from the 28,000 acre area will average $30 per AF. The impacts from these outlays would be in the form of additional purchases of diesel fuel for the pumps and O&M expense for the equipment.

2.2.7 Reduced Flows of Poor Quality Groundwater to Madera County

It was noted in Dr. Schmidt's report that the northeasterly direction of groundwater flow in the area developed many years ago and has permitted the migration of poor quality groundwater to the northeast, including parts of Madera County.[20] The Proposed Action would reduce that flow. However, as noted by Dr. Schmidt, the Proposed Action alone would be insufficient to fully address the poor quality groundwater in southwestern Madera County. Consequently, the impacts of the Proposed Action itself on these flows and related economic effects are not quantified for this analysis.

2.2.8 Regional Economic Effects

The direct, indirect, and total regional economic effects of the Proposed Action are presented in Table 15. The direct economic effects attributed to crop production (accounting for land fallowing) include $52.0 million in agricultural output, $10.7 million in direct income, and 470 direct jobs. These direct effects generate total economic effects of $83.8 million in output, $24.1 million in income and 975 jobs. These effects represent a decrease in economic benefits relative to existing conditions due to land fallowing; however, they also represent the continuation of economic benefits that would be otherwise completely lost under the No Action Alternative.

The conservation projects that would be implemented under the Proposed Action would also generate economic benefits. Assuming that these improvements would occur uniformly over the 25-year project timeframe, the new demand for water conservation services and infrastructure and related O&M would generate approximately $2.9 million in direct output, $1.3 million in direct income, and about 23 jobs on an annual basis in the four-county study area. These direct effects would generate additional indirect benefits that when totaled equal $4.5 million in total output, $1.9 in total income, and 40 jobs. These represent new economic benefits relative to existing conditions and future No Action conditions.

The payment to farmers for land fallowing program would also generate economic benefits as a result of increased farmer income. Under the Proposed Action, approximately $400,200 would be paid to farmers annually. These funds are assumed to be re-invested in farm equipment and spent locally as household income. Overall, the direct effects of the final demand generated by these payments include $0.3 million in annual output, $0.1 million in income, and roughly 3 jobs. In total, the annual output, income, and employment effects are estimated to be $0.4 million, $0.1 million, and about 4 jobs, respectively. These values represent a positive change from existing and future No Action conditions where no farm payments are made.

The Proposed Action also results in avoided costs for water treatment due to groundwater pumping of 15,000 AFY. Approximately $121,500 would be saved in treatment costs annually. On one hand, these funds would not be expended in the local water treatment sector, resulting in negative effects in the regional economy. On the other hand, the cost savings represent

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[20] Ken Schmidt, November 2005, "Groundwater Conditions in the Firebaugh Canal Water District and CCID Camp 13 Drainage District," Draft Report, p. 31.

additional income to farmers, which would likely be reinvested in farm equipment and spent locally as household income. Overall, the net direct effects of these avoided costs include a loss of approximately $42,100 in annual output, $28,600 in income, and less than one job. In total, the annual reductions in output, income, and employment are estimated to be $65,500, $38,400 and less than one job, respectively. These values represent a decrease in economic activity relative to existing and future No Action conditions.

In summary, the direct economic activity associated with the Proposed Action totals $55.1 million in annual output, $12.0 million in annual income, and 495 jobs. From a regional perspective, the total economic benefits generated in the four-county study area are 88.7 million in output, 26.2 million in income, and about 1,019 jobs on an annual basis over the 25-year project timeframe. A comparative summary of the total economic effects of the project alternatives is presented in Table 21.

Table 15. Direct and Regional Economic Effects: Proposed Action [1,2]

Measure	Direct	Indirect	Induced	TOTAL [3]
Crop Production 4				
Output ($ million)	$52.0	$18.6	$13.3	$83.8
Labor Income ($ million)	$10.7	$8.9	$4.6	$24.1
Employment (jobs)	470	364	142	975
Conservation Projects				
Output ($ million)	$2.9	$0.6	$1.0	$4.5
Labor Income ($ million)	$1.3	$0.3	$0.4	$1.9
Employment (jobs)	23	6	11	40
Payments to Farmers				
Output ($ million)	$0.3	$0.1	$0.1	$0.4
Labor Income ($ million)	$0.1	$0.0	$0.0	$0.1
Employment (jobs)	3	1	1	4
Avoided Costs – Water Treatment				
Output ($ million)	-$0.0	-$0.0	-$0.0	-$0.1
Income ($ million)	-$0.0	-$0.0	-$0.0	-$0.0
Employment (jobs)	-0	0	-0	-0
TOTAL: PROPOSED ACTION 3				
Output ($ million)	**$55.1**	**$19.2**	**$14.3**	**$88.7**
Labor Income ($ million)	**$12.0**	**$9.2**	**$5.0**	**$26.2**
Employment (jobs)	**495**	**371**	**153**	**1019**

1 Values represent average annual effects within the regional four-county economy (reported in absolute terms).

2 Monetary values reported in constant 2004 dollars.

3 Totals may not add to sum of rows and/or columns due to rounding.

4 Represents effects of crop production in the affected 28,000-acre area.

Source: ENTRIX, 2007 (based on IMPLAN modeling)

2.3 Alternative Action – Groundwater Pumping Only

Under this Alternative Action, up to 15,000 AFY of groundwater would be pumped to substitute for DMC water, with the pumped water potentially blended into the Outside and Main Canals of CCID. No water would be provided by conservation or land fallowing activities. Some of the direct impacts of the Alternative Action would include the following:

- Continued agricultural production.
- Reduced output of water from tile drains to be treated.
- Revenues to the Exchange Contractors from purchasers of DMC water.
- Expenditure of funds received by Exchange Contractors for the capital cost of wells, pumps, and infrastructure needed to pump groundwater and convey it to the CCID service area for mixing with DMC water before being applied to cropland in CCID.
- O&M expenditures by the Exchange Contractors to support new facilities and infrastructure.
- Regional economic effects associated with effects described above.

2.3.1 Continued Agricultural Production

With groundwater pumping only and no land fallowing, agricultural production in the affected 28,000-acre area would not change. Assuming that there would be no changes in crop yields, patterns, and prices (in real terms), agricultural activity under this alternative would produce approximately $55.6 million worth of agricultural commodities on an annual basis, which is equivalent to existing conditions.

2.3.2 Reduced Output of Water from Tile Drains to be Treated

Similar to the Proposed Action, the groundwater pumping-only alternative would generate about 15,000 AFY of groundwater for water transfers, thereby resulting in the same reduction in drain flows. Therefore, these impacts would be the same as those described for the Proposed Action (see Section 2.2.3).

2.3.3 Funds Received from Purchasers of Exchange Contractors Water

These impacts would be the same as those for the Proposed Action (see Section 2.2.4).

Expenditure of Funds Received by Exchange Contractors

Similar to the Proposed Action, the Exchange Contractors would use revenues derived from the proposed water transfer for the installation of new groundwater wells and pumps, water conservation measures, and water treatment. However, under this alternative, expenditures would be slightly higher because there would be no compensation to farmers for land fallowing. In total, the annualized capital costs of the project under the groundwater pumping-only alternative is nearly $1.8 million and total annual costs (including annual O&M) is almost $3.4 million (see Table 16).

Table 16. Conservation Program – Total and Annual Capital and O&M Costs: Alternative Action: Groundwater Pumping Only [1]

Program	Capital Costs		Annual O&M Costs	Total Annual Costs
	Total	Annual		
Irrigation Systems	$2,346,900	$142,300	$0	$142,300
Lining Facilities	$7,112,200	$431,500	$0	$431,500
Pumping/Conveyance	$12,244,900	$742,900	$816,300	$1,559,200
Drainage Treatment	$7,173,500	$435,100	$800,000	$1,235,100
Total	**$28,877,600**	**$1,751,800**	**$1,616,300**	**$3,368,200**

[1] Values reported in 2004 dollars.

Source: Exchange Contractors, 2005; ENTRIX, 2007

O&M Expenditures and Outlays for Pumping Groundwater

Because groundwater pumping levels are the same, related O&M expenditures would be the same as those for the Proposed Alternative (see Section 2.2.6).

Regional Economic Effects

The regional economic effects of the groundwater pumping-only alternative are presented in Table 17. In terms of crop production, direct economic effects include $55.6 million in agricultural output, $11.4 million in labor income, and 503 annual jobs. These direct effects generate total economic effects of $89.6 million in economic output, $25.8 million in income, and 1,043 jobs. While these effects do not represent a change from existing conditions, they represent the continuation of economic benefits that would be otherwise lost under the No Action Alternative.

The implementation of conservation projects under this alternative would also generate economic benefits. Assuming uniform expenditures over time, the new demand for water conservation services and infrastructure and related O&M would generate approximately $3.3 million in direct output, $1.5 million in direct income, and about 26 direct jobs on an annual basis in the four-county study area. These direct effects would generate additional indirect benefits that when totaled equal $5.1 million in total output, $2.2 in total income, and 45 jobs. These represent new economic benefits relative to existing conditions and future No Action conditions.

Similar to the Proposed Action, this alternative also entails avoided costs for water treatment. Because it is assumed that 15,000 AFY of groundwater would be pumped under either alternative, the same resulting regional economic impacts would be realized. Specifically, the net direct effects of these avoided treatment costs include losses of approximately $42,100 in annual output, $28,600 in income, and less than one job. In total, the annual reductions in output, income, and employment are estimated to be $65,500, $38,400 and less than one job, respectively. These values represent a decrease in economic activity relative to existing and future No Action conditions.

In summary, the direct economic benefits of the groundwater pumping-only alternative total $58.8 million in annual output, $12.9 million in annual income, and 528 jobs. From a regional perspective, the total economic benefits generated in the four-county study area are 94.7 million in output, $28.0 million in income, and roughly 1,088 jobs on an annual basis over the 25-year project timeframe. A comparative summary of the total economic effects of the project alternatives is presented in Table 21.

Table 17. Direct and Regional Economic Effects: Alternative Action – Groundwater Pumping Only [1,2]

Measure	Direct	Indirect	Induced	TOTAL [3]
Crop Production 4				
Output ($ million)	$55.6	$19.9	$14.2	$89.6
Labor Income ($ million)	$11.4	$9.5	$4.9	$25.8
Employment (jobs)	503	389	152	1,043
Conservation Projects				
Output ($ million)	$3.3	$0.7	$1.2	$5.1
Labor Income ($ million)	$1.5	$0.3	$0.4	$2.2
Employment (jobs)	26	7	13	45
Payments to Farmers				
Output ($ million)	--	--	--	--
Income ($ million)	--	--	--	--
Employment (jobs)	--	--	--	--
Avoided Costs – Water Treatment				
Output ($ million)	-$0.0	-$0.0	-$0.0	-$0.1
Labor Income ($ million)	-$0.0	-$0.0	-$0.0	-$0.0
Employment (jobs)	-0	0	-0	-0
TOTAL: ALTERNATIVE ACTION – GROUNDWATER PUMPING ONLY 3				
Output ($ million)	**$58.8**	**$20.5**	**$15.3**	**$94.7**
Labor Income ($ million)	**$12.9**	**$9.8**	**$5.3**	**28.0**
Employment (jobs)	**528**	**396**	**164**	**1,088**

[1]Values represent average annual effects within the regional four-county economy (reported in absolute terms).

[2]Monetary values reported in constant 2004 dollars.

[3]Totals may not add to sum of rows and/or columns due to rounding.

[4]Represents effects of crop production in the affected 28,000-acre area.

Source: ENTRIX, 2007 (based on IMPLAN modeling)

2.4 Alternative Action without Groundwater Pumping

Under this Alternative Action, up to 20,000 AFY of water would be developed for transfer from a combination of conservation and land fallowing. Conservation measures could be used to develop up to 15,000 AFY, and land fallowing could also provide up to 15,000 AFY. For this analysis, it is assumed that 15,000 AFY would be provided by land fallowing and 5,000 AFY by conservation measures.[21] The direct impacts from this Action Alternative would include the following:

[21] For the economic analysis, it is assumed that the maximum amount of land fallowing would occur so that the analysis represents worst-case economic conditions.

- Continued agricultural production on lands that are not fallowed.
- Payments to farmers for fallowed land.
- Revenues to the Exchange Contractors from purchasers of DMC water.
- Expenditures of funds received by the Exchange Contractors for various conservation projects and infrastructure.
- Expenditures of funds by the Exchange Contractors for operations and maintenance (O&M) activity to support new infrastructure.
- Regional economic effects associated with effects described above.

2.4.1 Continued Agricultural Production

Similar to the Proposed Action, agricultural production would continue to occur within the affected 28,000-acre area, albeit at reduced rates due to land fallowing. Based on an average value of 2.75 AF of irrigation water required per acre, it is estimated that approximately 5,455 acres of farmland would be fallowed under this alternative resulting in a loss of approximately $9.2 million in agricultural production value (see Table 18).

Table 18. Fallowed Land Acreage, Gross Value, and Net Income in the Affected 28,000-Acre Area: Alternative Action without Groundwater Pumping

	Acres		Per Acre		Fallowed Acre Totals	
Crop	**Total**	**Fallowed**	**Gross Value[1]**	**Net Profit [2]**	**Gross Value**	**Net Profit**
Cotton	11,955	3,293	$1,343	$422	$4,422,100	$1,388,800
Alfalfa	5,004	1,378	$933	-$72	$1,285,900	-$99,000
Melons	2,845	784	$4,505	-$114	$3,530,100	-$89,300
Total	19,804	5,455	--	$220.09 [3]	$9,238,100	$1,200,500

[1] Based on 2004 agricultural commissioner reports for the four-county area as presented by the California Agricultural Statistics Service (2004).
[2] Based on crop yields and prices reported in CASS (2004) and various crop budgets produced by the University of California Cooperative Extension. For cotton, see UC Extension, 2003a. For alfalfa, see UC Extension, 2003b. For melons, see UC Extension, 2004.
[3] Represents weighted average across crop groups in 2004 dollars.

Source: California Agriculture Statistics Service (CASS), 2004; ENTRIX, 2007

2.4.2 Payments to Farmers for Fallowed Land

Based on average net profits for the crops grown in the project area ($220 per acre) and land fallowing of 5,455 acres, total payments to farmers are estimated to be about $1.2 million annually under this alternative (see Table 18). (The data and assumptions used to calculate these values are described in Section 2.2.2.) Similar to the Proposed Action, it is assumed the payments for fallowing are divided equally between outlays for farm machinery and equipment and household consumption.

2.4.3 Funds Received from Purchasers of Exchange Contractors Water

These impacts would be the same as those for the Proposed Action (see Section 2.2.4).

2.4.4 Expenditure of Funds Received by Exchange Contractors

Under this alternative, payments to farmers for land fallowing represent a large source of annual expenditures ($1.2 million), which would not be available for other uses. In addition, approximately 5,000 AF of water is assumed to be provided by conservation programs, which would be paid by revenues from the proposed water transfer. The major difference between this alternative and the other two action alternatives is that no new groundwater wells would be installed since there would be no groundwater pumping. Instead, the capital expenditures that would have been made for groundwater pumping are assumed to be spent on additional irrigation improvements and lining of facilities. Based on these parameters, the annualized capital costs over the 25-year project are estimated at about $551,300. These data, including annual O&M expenditures described below, are shown in Table 19.

Table 19. Conservation Program – Total and Annual Capital and O&M Costs: Alternative Action without Groundwater Pumping

Program	Capital Costs		Annual O&M Costs	Total Annual Costs [1]
	Total	Annual		
Irrigation Systems	$748,500	$45,400	$0	$45,400
Lining Facilities	$1,169,700	$71,000	$0	$71,000
Pumping/Conveyance	--	--	--	-
Drainage Treatment	$7,173,500	$435,000	$800,000	$1,235,000
Total [1]	$9,091,700	$551,300	$800,000	$1,351,300

[1] Totals may not add up to sum of rows and columns due to rounding.

Source: Exchange Contractors, 2005; ENTRIX, 2007

2.4.5 O&M Expenditures by Exchange Contractors

No O&M expenditures would be required for groundwater pumping since it is not included as part of this alternative. It is assumed that the O&M expenditures that would be required for groundwater pumping under the Proposed Action would not be spent elsewhere. As shown in Table 19, annual O&M expenditures are estimated to be about $800,000 million under this Action Alternative.

2.4.6 Regional Economic Effects

The direct, indirect, and total regional economic effects of the Alternative Action are presented in Table 20. The direct annual economic effects attributed to crop production on the 22,545 acres of land remaining in production in the study area would include $44.8 million in agricultural output, $9.2 million in direct income, and 405 direct jobs. These direct effects would generate total economic effects of $72.2 million in annual output, $20.8 million in annual income, and 840 jobs. These effects represent a slight decrease from the Proposed Action because of fallowing 5,455 acres rather than 1,818 acres. However, these values represent economic benefits that would otherwise be lost under the No Action Alternative.

The conservation projects and related O&M that would be implemented under the Alternative Action would also generate approximately $1.3 million in direct output, $0.6 million in direct income, and 10 direct jobs on an annual basis in the four-county study area (assuming that these improvements would occur uniformly over the 25-year project timeframe). The total economic effects (direct and indirect) attributed to conservation projects equal $2.0 million in total annual output, $0.9 million in total annual income, and 18 jobs. These are new benefits relative to existing and future No Action conditions.

The payment to farmers under the land fallowing program would also generate economic benefits. Approximately $1.2 would be paid to farmers on an annual basis. These funds are assumed to be re-invested in farm equipment and spent locally as household income. Overall, the direct effects of the final demand generated by these payments include $0.8 million in annual output, $0.3 million in income, and about 7 jobs. In total, the annual output, income, and employment effects are estimated to be 1.2 million, $0.4 million, and roughly 12 jobs, respectively. These values represent a positive change from existing and future No Action conditions.

In summary, the direct economic benefits of the Alternative Action total $46.9 million in output, $10.1 million in income and 422jobs. From a regional perspective, the total economic benefits generated in the four-county study area are $75.4 million in output, $22.1 million in income, and 870 jobs on an annual basis over the 25-year project timeframe.

Table 20. Direct and Regional Economic Effects: Alternative Action without Groundwater Pumping [1,2]

Measure	Direct	Indirect	Induced	TOTAL [3]
Crop Production 4				
Output ($ million)	$44.8	$16.0	$11.4	$72.2
Labor Income ($ million)	$9.2	$7.6	$4.0	$20.8
Employment (jobs)	405	313	122	840
Conservation Projects				
Output ($ million)	$1.3	$0.3	$0.5	$2.0
Labor Income ($ million)	$0.6	$0.1	$0.2	$0.9
Employment (jobs)	10	3	5	18
Payments to Farmers				
Output ($ million)	$0.8	$0.2	$0.2	$1.2
Labor Income ($ million)	$0.3	$0.1	$0.1	$0.4
Employment (jobs)	7	2	3	12
Avoided Costs – Water Treatment				
Output ($ million)	--	--	--	--
Labor Income ($ million)	--	--	--	--
Employment (jobs)	--	--	--	--
TOTAL: ALTERNATIVE ACTION WITHOUT GROUNDWATER PUMPING 3				
Output ($ million)	**$46.9**	**$16.4**	**$12.1**	**$75.4**
Labor Income ($ million)	**$10.1**	**$7.8**	**$4.2**	**22.1**
Employment (jobs)	**422**	**318**	**129**	**870**

[1]Values represent average annual effects within the regional four-county economy (reported in absolute terms).
[2]Monetary values reported in constant 2004 dollars.
[3]Totals may not add to sum of rows and/or columns due to rounding.
[4]Represents effects of crop production in the affected 28,000-acre area.

Source: ENTRIX, 2007 (based on IMPLAN modeling)

2.4 Summary of Regional Economic Effects Across Alternatives

Table 21 compares the regional economic impacts of the No Action, Proposed Action, and the two Action Alternatives. All impacts are presented in annual terms relative to Existing Conditions, i.e. those prevailing in 2004. As shown, total current regional output corresponding to crop production in the 28,000 acre area is $89.6 million per year, while income is $25.8 million, and employment is 1,043 jobs.

Under No Action, all 28,000 acres of cropland would go out of production by the end of the study period, leading to losses equal to the economic activity generated under existing conditions. Further, it is assumed no water would be sold by the Exchange Contractors other than the programs currently in place. Similarly, there would no change in construction of conservation projects, no payments to farmers for fallowing land, and no avoided costs for treating drain water relative to current programs. Consequently, the impacts for these latter three categories under the No Action Alternative are zero. Overall, the net regional impacts associated with the No Action Alternative include an annual loss of $89.6 million in output, $25.8 million in income, and 1,043 jobs.

Under the Proposed Action, there would be a decrease in crop production relative to existing conditions as a result of land fallowing. Consequently, the regional economic activity attributed to crop production impacts is lower relative to existing conditions. Specifically, implementation of the Proposed Action would result in an estimated loss of $5.8 million in total economic output, $1.7 million in total labor income, and 68 annual jobs compared to existing conditions. However, wells, pumps, and related infrastructure would be purchased for groundwater pumping, and conservation projects would be built. In annualized terms, the total direct costs of these improvements would be almost $1.4 million per year. Annual operations and maintenance costs would be $1.6 million per year. The total regional impacts associated with these outlays would be $4.5 million in output, $1.9 million in personal income, and 40 new jobs. The avoided costs of water treatment of about $121,500 arise from no longer having to treat approximately 101 AFY of drain water (see Section 2.2.3). The net direct and total regional economic effects from the avoidance of drainage treatment costs are negligible. Overall, under the Proposed Action, total regional output is estimated to decrease by $0.9 million annually relative to existing conditions, while total income decreases $0.4 million annually, and employment decreases by 24 jobs.

Under the Alternative Action with substitute water from groundwater pumping only, all land would remain in production (agricultural production would remain at current levels), and yields, prices, and production costs are assumed to remain constant. As aresult, the regional economic effects of agricultural production would not change. Wells, pumps, and related infrastructure would be purchased for groundwater pumping, and conservation projects would be built. The total direct costs of these improvements would be $28.9 million, or, annualized, $1.8 million per year. Annual operations and maintenance costs would be $1.6 million per year. The total regional impacts associated with these outlays would be $5.1 million in output, $2.2 million in personal income, and 45 new jobs. Similar to the Propsoed Action, the avoided costs of water treatment arise from no longer having to treat approximately 101 AFY of drain water, resulting in cost savings of $121,500 per year. The regional economic effects associated with reduced water treatment costs would be negligible. In sum, under the groundwater pumping-only alternative, total regional output increases $5.1 million annually relative to existing conditions, while total income increases $2.2 million annually, and employment increases by 45 jobs.

The greatest adverse economic effects are expected under the Alternative Action without groundwater pumping. Under this scenario, crop production declines because of the fallowing of 5,455 acres. The regional economic output impact associated with the fallowing of agricultural land is a decline of $17.4 million per year relative to existing conditions, while income falls $5.0 million annually, and employment declines by 203 jobs. Because of conservation programs and payments to farmers (the latter equivalent to the profits normally earned from the fallowed lands), the adverse output, income, and employment effects associated with fallowing are partially offset. The net regional impacts of fallowing, conservation programs, and payments to farmers include annual losses of $14.2 million in output, $3.7 million in income, and 173 jobs, all relative to existing conditions.

Table 21. Summary of Regional Economic Effects [1,2]

Type of Impact	Existing Conditions[3]	No Action	Proposed Action	Alternative Action: Groundwater Pumping Only	Alternative Action without Groundwater Pumping
Crop Production 4					
Total Output ($ million)	$89.6	- $89.6	- $5.8	$0	- $17.4
Total Labor Income ($ million)	$25.8	- $25.8	- $1.7	$0	- $5.0
Total Employment	1,043	- 1,043	- 68	0	- 203
Conservation Projects					
Total Output ($ million)	--	$0	+ $4.5	+ $5.1	+ $2.0
Total Labor Income ($ million)	--	$0	+ $1.9	+ $2.2	+ $0.9
Total Employment	--	0	+ 40	+ 45	+ 18
Payments to Farmers					
Total Output ($ million)	--	$0	+ $0.4	$0	+ $1.2
Total Labor Income ($ million)	--	$0	+ $0.1	$0	+ $0.4
Total Employment	--	0	+ 4	0	+ 12
Avoided Costs – Water Treatment					
Total Output ($ million)	--	$0	- $0.1	- $0.1	$0
Total Labor Income ($ million)	--	$0	- $0.0	- $0.0	$0
Total Employment	--	0	- 0	- 0	0
Project Totals					
Total Output ($ million)	$89.6	- $89.6	- $0.9	+ $5.1	- $14.2
Total Labor Income ($ million)	$25.8	- $25.8	- $0.4	+ $2.2	- $3.7
Total Employment	1,043	- 1,043	- 24	+ 45	- 173

[1] For the project alternatives, values represent average total annual effects within the regional four-county economy. Reported in terms of changes relative to existing conditions (2004 baseline)
[2] Monetary values reported in constant 2004 dollars.
[3] Reported in absolute terms.
[4] Represents effects of crop production in the affected 28,000-acre area. For the No Action Alternative, values are based on

production at the end of the project period (year 2033).

Source: ENTRIX, 2007 (based on IMPLAN modeling)

2.5 Cumulative Impacts

Cumulative impacts include those of the alternatives discussed in this report and, potentially, several policies in different stages of implementation, some quantifiable, others not. By themselves, the impacts estimated for the Action Alternatives in this study are not significant for the four-county study area. The total amount of cropland harvested in the four counties in which the Exchange Contractors service area is located has changed little since 1990. Cropland harvested has varied by as much as 35,000 acres per year. Thus, idling of a maximum of up to 5,455 acres of Exchange Contractors land, as described for the Alternative Action without Groundwater Pumping, would be within the normal range of variation and would not be significant, all other factors unchanged.

While the permanent retirement of the entire 28,000 acre area under the No Action Alternative would be less than significant relative to cropland acreage for the four counties, it would be significant in the Exchange Contractors service area, accounting for almost 12 percent of the total. Moreover, several areas within the San Joaquin Valley could be idled permanently because of water supply shortages and subsurface drainage problems. As noted by the U.S. Bureau of Reclamation (September 2005), more than 109,000 acres would be retired within the San Luis Unit under both the No Action and Preferred Alternatives described for the long-term contract renewal for that Unit.

Assuming all retired land for the San Luis Unit as well as the No Action Alternative would be in Fresno County, cumulatively about nine percent of the total cropland acreage in that county would be taken out of production, a significant impact. However, it should be noted that the fallowing of San Luis Unit land alone constitutes a significant impact using the five percent criterion discussed previously. The impacts of fallowing in the Exchange Contractors area would be offset by the payments for water sold and investment in groundwater extraction, conservation, and irrigation system improvements. Relative to overall economic measures for the four counties, the impacts may be relatively small. However, impacts within smaller communities, particularly those on the west side of the San Joaquin Valley, may be significant.

Other potential cumulative impacts are not quantified. For example, the provisions of CALFED are not yet fully implemented and the effects on Delta exports are not fully known. Other laws or policies which may affect parties that would be affected by the alternatives in this study include, but are not limited to, Total Maximum Daily Load limits on agricultural discharges and restrictions on on-farm stationary engines. In addition, the potential impacts of the Environmental Water Account are not included among cumulative impacts. The conditions underlying such purchases are unpredictable, other than CALFED's goal of purchasing at least 190,000 acre-feet of water each year, and such transfers may be "repaid" with additional water releases at other times. Consequently, the impacts are unknown.

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Attachment A
REGIONAL IMPACT ESTIMATION AND INPUT-OUTPUT ANALYSIS

Regional analysis is a form of economic analysis that recognizes the distinctness of a geographical area in terms of its resources, industries, and relationships with other areas. In general, smaller regional economies are more dependent on trade with other regions for "imports" and "exports" of goods and services than are larger regions. Regional growth is enhanced by the outputs of its export industries. In this study, agriculture and sectors related to agriculture export many of their products outside the region and are consequently important contributors to growth in the area.

For this study, input-output (I-O) analysis is used to measure the regional impacts of the No Action and Action alternatives. I-O analysis quantitatively measures the interdependence among economic sectors. Each sector not only produces goods and services, but also purchases goods and services for use in the production process. Regional I-O analysis is based on a framework developed for the national economy and modified to reflect regional differences in production processes.

A set of I-O accounts can be thought of as a snapshot of the economic structure of an area at one point in time. For this analysis, 2002 data were used to develop a model of the four-county area within which the Exchange Contractors service area is located.

The model was developed using IMPLAN software and data, utilized regularly by many professionals for economic impact analyses. The model was developed for the four-county area rather than one or two counties because of the logical relationships among counties. Activities in Fresno and Merced Counties are very likely to affect not only those, but also the neighboring counties of Madera and Stanislaus. For example, farmers in Fresno and Merced Counties purchase inputs, such as machinery, chemicals, and seed from suppliers throughout the area. Hired laborers working on farms and in other industries in the two counties likely reside in all four counties. Products from farms in the two counties, such as cotton, tomatoes, fruits, nuts, and melons, are shipped, brokered, and processed in all four counties.

The primary inputs for the I-O model are described in the Impact Analysis section of this report, and include the farm-level, district-level, and Exchange Contractor levels of activities. For each alternative, direct impacts are estimated based on the source(s) of substitute water; receipts for water transferred to other CVP contractors and Exchange Contractor outlays for wells, pumps, other machinery and equipment, and conservation programs; impacts of changes in water quality on crop yields and cropping patterns; land fallowing; and other pertinent measures.

The IMPLAN model is used for each alternative to translate any changes in crop yields and agricultural production and outlays for wells and pumps and other program-financed expenditures into changes in final demand expenditures by sector, then into levels of employment and income. The changes in relation to baseline conditions represent the direct impacts that are used in the I-O model for estimation of total regional impacts.

Impacts are classified as direct, indirect, and induced. Because businesses within a local economy are linked together through the purchase and sales patterns of goods and services in the area, an action which has a direct impact on one or more local industries is likely to have an impact on many other businesses in the region. For example, a decline in agricultural production, which would be expected under the No Action/No Project Alternative, would lead to a decline in local crops available for further processing and a decline in purchases of fertilizer, feed, and farm machinery. Firms providing production inputs and support services to farmers and food processors would see a decline in their revenues as the demand for machinery and other inputs, and supplies of raw products, respectively, for their businesses also decline. These additional effects are known as the indirect economic impacts.

As household income is affected by the reductions in regional economic activity, additional economic impacts occur. Reduced demand by consumers will further decrease the demand for local goods and services, leading to additional economic impacts throughout the economy. These additional effects generated by reduced household spending are known as induced economic impacts.

The tool used to measure direct, indirect, and induced impacts is known as a multiplier. Many multipliers are generated by an input-output model and each is associated with a specific industry. A multiplier is a single number which quantifies the total regional economic effects (for all businesses) which arise from direct changes in economic activity. Multipliers can be generated to measure the total output, income, or employment effects associated with changes in the demand for regional goods and services. For example, an output multiplier of 2.5 for vegetable production indicates that a $100,000 decline in output from this industry (due to crop yield declines and/or land idling) would lead to an overall output decline of $250,000 in the regional economy, including the initial $100,000 loss to lodging sector. An employment multiplier of 2.0 for vegetable production indicates that a loss of 100 jobs in this sector would lead to an additional loss of 100 jobs in other industries for a total loss of 200 jobs throughout the regional economy.